

CA1 EP 76078W01

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Water Quality Interpretive Report No.1

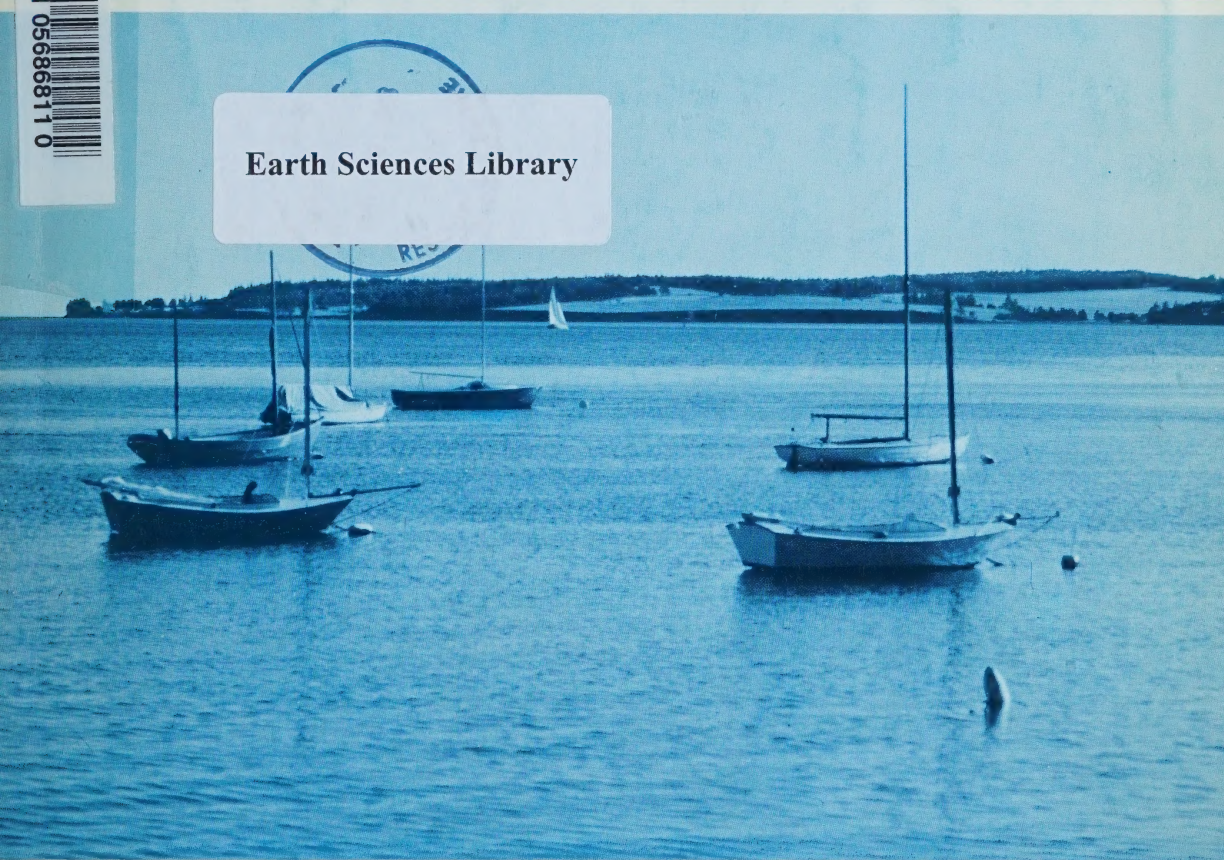
WATER QUALITY INTERPRETIVE REPORT, PRINCE EDWARD ISLAND,
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(Résumé en français)

Canada

INLAND WATERS DIRECTORATE,
WATER QUALITY BRANCH,
OTTAWA, CANADA, 1978.

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Water Quality Interpretive Report, Prince Edward Island, 1961-1973

R.N. McNeely and V.P. Neimanis

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(Résumé en français)

**INLAND WATERS DIRECTORATE,
WATER QUALITY BRANCH,
OTTAWA, CANADA, 1978.**

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Cat. No. EN 36-424/1

ISBN 0-662-01737-4

Contract No. KL229-7-1018

THORN PRESS LIMITED

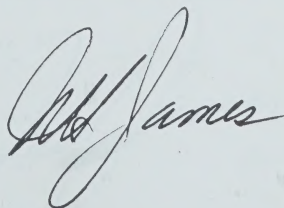
Foreword

Canada is a land richly endowed with an abundance of fresh water contained in a myriad of sparkling streams and lakes as well as large navigable rivers. It is becoming clear, however, that our water resources are not limitless and that some areas are even now in danger of running short of useable water. Along with a growing awareness that our water resources are limited in certain areas of Canada, concerns for the *quality* of the water throughout Canada are rapidly developing.

Most water uses, be they recreational, agricultural, industrial, or domestic, have very specific requirements for the quality of the water resource. In many instances, the water quality dictates the limitations on the use of a water resource. Therefore, the quality of a water resource can have profound implications on the social and economic development of an area.

Fisheries and Environment Canada has monitored the quality of many of Canada's major surface waters for a number of years. The National Monitoring Program carried on by the Water Quality Branch of the department has varied over the years but has gradually expanded to include approximately one thousand sampling sites, which reflect national, regional, and local water quality concerns. The data are stored on NAQUADAT, the data processing system of the Branch, and are periodically published in summary form in the Water Quality Branch Data Report Series. Although these summaries have proven valuable as reference data sources, it has been realized that these reports can only be fully utilized by persons familiar with the interpretation of water quality data. In order to involve a wider audience in the appreciation of water quality data, this new series, Water Quality Interpretive Reports, has been produced. This report and future ones will parallel the Water Quality Data Summary Reports. It is anticipated that this type of report will extend the basic understanding of water quality by utilizing the existing historical water quality data which have been collected by both federal and provincial agencies and entered onto NAQUADAT. These reports will emphasize pertinent water quality information through the use of graphical, tabular, and concise textual presentations.

Individual reports will aim at interpreting regional water quality data for a broad spectrum of uses. It is hoped that these reports will be informative and useful to the public and resource planners.

A handwritten signature in dark ink, appearing to read 'N.H. James', is positioned above the printed name and title.

N. H. James
Director General
Inland Waters Directorate

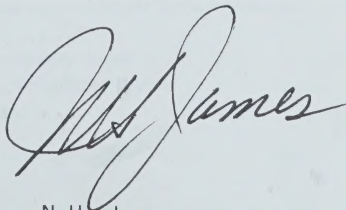
Avant-propos

Le Canada est un pays abondamment pourvu de vastes réserves d'eau douce emmagasinées dans une myriade de rivières et lacs miroitants ainsi que grands cours d'eau navigables. Il devient toutefois évident qu'il existe une limite à nos ressources en eau et que certains endroits au pays sont menacés, à l'instant même, par une pénurie d'eau propre. En même temps que s'effectue cette prise de conscience accrue en ce qui concerne la disponibilité des ressources en eau dans des régions données du pays, l'intérêt suscité par la qualité des eaux augmente considérablement à travers le Canada.

La plupart des utilisations de l'eau, à savoir récréatives, agricoles, industrielles ou domestiques, ont des normes bien définies en matière de qualité des ressources en eau. Dans bien des cas, la qualité des eaux gouverne les exigences des utilisations possibles des ressources en eau. En fait, la qualité de ses ressources en eau peut avoir des significations profondes sur le développement économique et social d'une région.

Le ministère de l'Environnement du Canada surveille la qualité de plusieurs nappes d'eaux de surface importantes au pays depuis maintes années. Le programme national de surveillance mise en oeuvre par la Direction de la qualité des eaux du Ministère, a varié en importance au cours des années et s'est graduellement étendu à environ mille stations d'échantillonnage qui reflètent toutes des intérêts nationaux, régionaux et locaux en matière de qualité des eaux. Les données sont emmagasinées dans la banque NAQUADAT, système d'automatisation des données de la Direction, et sont publiées à intervalle régulier sous forme d'extraits comme composants des séries de rapports de la Direction de la qualité des eaux. Quoiqu'utiles en tant que sources de données de base, les extraits semblent principalement destinés aux utilisateurs connaissant les modes d'interprétation des données sur la qualité des eaux. C'est pour encourager la dissémination des données sur la qualité des eaux et améliorer la compréhension d'un public bien informé, que la présente collection intitulée *Water Quality Interpretive Reports* est publiée. Le présent rapport ainsi que les autres qui paraîtront égaleront les rapports sommaires des données sur la qualité des eaux. Un rapport de ce genre tente de faire mieux connaître les divers éléments de la qualité des eaux en ayant recours aux données historiques actuelles recueillies à la fois par des organismes fédéraux et provinciaux et enregistrées dans la banque NAQUADAT. Les nouveaux rapports vont mettre en relief l'information qui a rapport à la qualité des eaux en s'appuyant sur des graphiques, des tableaux et un texte clair et concis.

Chaque rapport constituera une interprétation des données sur la qualité des eaux régionales en fonction d'une gamme d'utilisations possibles. De cette façon, les rapports seront du genre didactique et pourront être utilisés par le grand public et les responsables de la gestion des ressources en eau.



N. H. James
Directeur général
Direction générale des
eaux intérieures

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Abstract

The Water Quality Branch, Fisheries and Environment Canada, is endeavouring to involve a wider audience in an appreciation of water quality information by publishing a new report series: Water Quality Interpretive Reports. Report No. 1 deals with the historical water quality data available from NAQUADAT for Prince Edward Island. Approximately 1600 samples, relating to 4 stream stations, 32 groundwater, and 60 estuary sites, were collected by federal and provincial agencies during the 12-year period 1961-1973 and analyzed for as many as 50 parameters.

The major ion chemistry of Prince Edward Island surface and groundwaters was well defined. The dissolved major ions for surface waters could satisfactorily be estimated from discharge measurements by using site-specific, empirically derived equations, whereas the constituents of environmental concern, such as nutrients and contaminants, could not be adequately assessed by a monthly sampling program.

A decline in surface water pH was observed over the 8-year period 1966-1973 at the Mill River site. Since there was an inverse relationship between stream pH and discharge at the site, the decreasing pH may have resulted solely from an increase in surface runoff, although the possible enhancement of the pH change by the deposition of acid aerosols into an environmentally

sensitive area should be considered in future monitoring programs.

An analysis of the Prince Edward Island water quality data in relation to specific-use guidelines revealed that:

- i) the sampling programs were not designed to determine whether specific-use guidelines were being met;
- ii) surface and groundwaters on Prince Edward Island would have required at least minimal treatment to meet the *objective* levels for domestic consumption and food processing;
- iii) direct agricultural use of both surface and groundwaters would have posed no serious problems; whereas
- iv) the use of both surface and groundwaters for high-pressure steam generation would have required treatment;
- v) anthropogenic heavy metal and nutrient pollution of many of the estuaries was in evidence; however
- vi) the special pesticide surveys conducted in the early 1970's indicated less than five per cent of the analyzed values were above the detection limit of the analytical methods used. The pesticide of most concern, α -BHC, was detected in the Summerside, Charlottetown Harbour-Hillsborough and Cardigan Bay Estuaries.

Résumé

La Direction de la qualité des eaux du ministère des Pêches et de l'Environnement du Canada souhaite mettre à la portée de tous les renseignements disponibles sur la qualité des eaux en faisant paraître une nouvelle collection de rapports intitulée *Water Quality Interpretive Reports*. Le premier de ces rapports renferme les données historiques de la qualité des eaux recueillies pour l'Île du Prince-Édouard et extraites de la banque NAQUADAT. Durant la période de 12 années s'étendant de 1961 à 1973, des organismes fédéraux et provinciaux ont prélevé quelque 1600 échantillons d'eau à 4 stations de jaugeage de cours d'eau, à 32 stations d'eaux souterraines et à 60 stations d'estuaires, et les ont analysés en fonction d'au moins 50 paramètres spécifiques.

L'ion chimique prédominant dans les eaux de surface et les eaux souterraines de l'Île du Prince-Édouard a pu être déterminé avec précision. À partir des relevés de débits et grâce aux équations dérivées empiriquement pour chaque emplacement donné, les principaux ions dissous des eaux de surface ont pu être évalués avec satisfaction. En revanche, les composants d'intérêt environnemental, tels que les substances nutritives et les contaminants, n'ont pas pu être estimés de façon adéquate par un programme d'échantillonnage fait sur une base mensuelle.

Les relevés effectués sur les eaux de surface à la station de la rivière Mill pendant la période de 8 années allant de 1966 à 1973, indiquent une diminution des concentrations en pH. Puisque le cours d'eau a connu un renversement dans ses valeurs de pH et de débit, la diminution des concentrations en pH semblerait être causée par la seule hausse du taux de ruissellement superficiel; cependant, tout programme de surveillance devra à l'avenir étudier les répercussions possibles

d'aérosols acides se déposant dans un tel domaine environnemental sensible.

Une analyse des données sur la qualité des eaux de l'Île du Prince-Édouard, à la lumière des directives établies pour les utilisations particulières, a mis en évidence que:

- i) les programmes d'échantillonnage n'étaient pas conçus de manière à déterminer si les lignes directrices pour les utilisations spécifiques étaient respectées;
- ii) les eaux de surface et les eaux souterraines de l'Île du Prince-Édouard auraient toutes deux nécessité un traitement primaire afin de répondre aux normes *objectives* exigées de l'eau destinée à la consommation domestique et aux industries alimentaires;
- iii) l'utilisation directe des eaux de surface ainsi que des eaux souterraines pour des fins agricoles n'aurait engendré aucun problème sérieux; tandis que
- iv) les eaux de surface de même que les eaux souterraines devant servir pour la production de vapeur à haute pression, auraient exigé un traitement préliminaire;
- v) la pollution anthropogène provenant des métaux lourds et des substances nutritives était notable dans maints estuaires; cependant
- vi) les relevés spéciaux menés sur les pesticides au début des années 70, indiquaient que cinq pour cent des valeurs déterminées étaient supérieures aux limites de détection des méthodes analytiques utilisées. Le pesticide le plus sérieux (α -BHC), se retrouvait dans les estuaires de Summerside, du port de Charlottetown-baie Hillsborough, et de la baie Cardigan.

Introduction

This interpretive report parallels the Water Quality Summary Report for Prince Edward Island (Environment Canada, 1976) and, therefore, deals specifically with the water quality data available from NAQUADAT (National Water Quality Data Storage and Retrieval System) for the Province of Prince Edward Island and generated during the time period 1961 to 1973. The interpretation presented here is based solely on a data base which terminates in 1973. Since more recent data may be available, minor revisions to this interpretation may be warranted in light of new information. The NAQUADAT system is a repository of water quality information including chemical, physical, biological, and selected hydrometric data which are stored for surface, ground-water, wastewater, precipitation, and other "water-types". All NAQUADAT data are catalogued by a station number and time. The various NAQUADAT "water-types" have been colour-coded for ease of identification, and the station locations relevant to this report are illustrated on Figure 1 (Appendix IV).

Historical Prince Edward Island water quality data are available for 4 stream/river stations, 32 groundwater stations, 60 estuary, and 3 open ocean sampling sites. These data were presented in summary form in an earlier publication (Environment Canada, 1976). Data collected from a number of rivers, lakes, and estuaries by the provincial Department of the Environment during a special pesticide survey in 1971-1972, which have not been previously published, have also been included.

The four stream sampling sites, namely the Mill, Dunk, and Brudenell Rivers and North Brook (stations 00PE01CA0001, 00PE01CB0001, 00PE01CE0001 and 00PE01CB0017, respectively) are indicated in green on Figure 1 (Appendix IV). In the 8-year period (1966-1973) approximately 275 water samples were taken at these four stations and chemically analyzed for about 30 parameters.

During 1972-1973 over 300 samples were collected at the 32 groundwater stations and chemically analyzed for some 30 parameters. The groundwater sites are indicated in purple on Figure 1 (Appendix IV).

Prince Edward Island's shoreline consists of numerous estuaries. The estuary sampling locations are shown in orange on Figure 1 (Appendix IV). Since water samples from sites within the freshwater/marine interface relate to two different sampling programs, the data have been segregated into two sub-sets for certain mathematical analyses. In 1972 to 1973, 30 sites were sampled for a full range of water quality parameters including major ions, metals and pesticides. Up to 54 parameters were chemically analyzed on about 720 samples and recorded on data set I. In 1973 an additional 30 sites were sampled for a limited number of parameters, primarily heavy metals. Only 14 parameters on approximately 300 samples were chemically analyzed and are available on data set II.

There were three ocean sampling sites reported in the Prince Edward Island data summary, one each near Alberton, Rustico, and Murray Harbour entrances. These sites appear in red on Figure 1 (Appendix IV). Twelve parameters were chemically analyzed on 23 samples at these three sites in 1973.

During the early seventies a special province-wide survey was conducted in which 68 stream locations, 3 lake sites, and 39 estuary sites in addition to the 60 estuary sites noted above were sampled for a maximum of 17 pesticides, cadmium, and mercury. A number of locations had multiple samples collected, but most sites were sampled only once. Although the data collected by this special survey was generated using the best sampling and analytical methodologies available at the time, certain sampling and analytical problems became evident only after the data generation process was completed. Water Quality Branch scientists have recently identified the possibility that samples with elevated chloride concentrations, such as estuarine and marine waters, may generate spuriously high mercury results when analyzed by the automated "Hatch and Ott" technique (Goulden and Afghan, 1970). Although a number of such data have been generated by this survey on estuarine samples, such data have been excluded from this interpretive work.*

* An excellent review of the status of Mercury in the Atlantic Provinces is available (Wilson and Travers, 1976).

Although samples were collected by both water quality technologists and lay-collectors for federal and provincial agencies, essentially all of the samples were analyzed in the Atlantic Region's Water Quality Branch Laboratory in Moncton, N.B., using prescribed analytical techniques (Environment Canada, 1974). Detailed listings of the data are available upon request.*

* Requests for data and/or publications should be sent to:

Head,	or Chief,
Data and Instrumentation Section,	Water Quality Branch,
Water Quality Branch,	Inland Waters Directorate,
Inland Waters Directorate,	Department of the Environment,
Department of the Environment,	P.O. Box 861,
Ottawa, Ontario,	Moncton, New Brunswick,
K1A 0E7	E1C 8N6

Major Ion Chemistry

Natural waters including streams, lakes, groundwaters, etc. can be categorized by their chemical composition. Since all waters contain varying amounts of eight major ions (dissolved constituents), the chemical type of water can be defined by assessing the proportions of each of these ions in the water. The ions in solution can be segregated into two groups, namely the negatively charged ANIONS (e.g. carbonate, bicarbonate, chloride, and sulphate), and the positively charged CATIONS (e.g. potassium, sodium, calcium, and magnesium)*. Thus the chemical water type, but not necessarily the water quality, at a sampling site can be defined. This simple yet fundamental assessment of water types allows further insight into the possible origins of the water, its buffering capacity, and various other chemical and biological interactions which may occur.

FRESH WATER

Surface Water

Fresh water, which is primarily derived from atmospheric precipitation, typically exhibits a calcium bicarbonate composition unless unduly influenced by soil, bedrock, or exogenous inputs to the drainage basin. Of the four stream stations, designated by green numerals on Figure 2, (Appendix IV), the Dunk River and North Brook exemplify this water composition, whereas the Mill and Brudenell Rivers show an increase in magnesium probably due to dolomitic cementing agents in the bedrock within the drainage basin.

The ionic strength or freshwater salinity of the water at these four stations, as indicated by their total dissolved

solids (TDS) concentrations, was relatively low with median values for three of the stations ranging between 85 and 95 mg/L while the fourth station exhibited a level of 116 mg/L. The buffering capacity of these surface waters, as indicated by their alkalinity values, was also moderately low with median alkalinities ranging from 60 to 75 mg/L (as CaCO_3).

Groundwater

Groundwaters are strongly influenced by the composition of the aquifers, that is, the surficial deposits (overburden) and/or the bedrock in which the water is resident. The ionic proportion patterns for the groundwater stations (designated by purple, Figure 2, Appendix IV), indicate that there were two distinct types of groundwater on Prince Edward Island, specifically calcium bicarbonate and calcium-magnesium bicarbonate water.

All of the groundwater stations in the eastern portion of the province, Queens and Kings Counties, with the exception of the Kinlock well southeast of Charlottetown, and the Unionvale well near O'Leary exhibited a calcium-magnesium bicarbonate water possibly due to a dolomitic influence in the sub-surface deposits. The Springfield, New Annan, and Bloomfield Station wells (01CB0010, 01CB0012, and 01CA0005) also indicated a probable dolomitic influence in their aquifers.

All of the groundwater stations within the '01CB' drainage area and the Mount Pleasant well (01CA0004) exhibited a calcium bicarbonate composition. The Albany, Fernwood, and Mount Carmel wells (01CB0011, 13, and 14) in addition to the Elmwood well (01CC0019) showed slight increases in sodium chloride.

*Detailed descriptions of all the parameters presented in the "Prince Edward Island Data Summary Report", (Environment Canada, 1976), and discussed in this interpretive report appear in Appendix II.

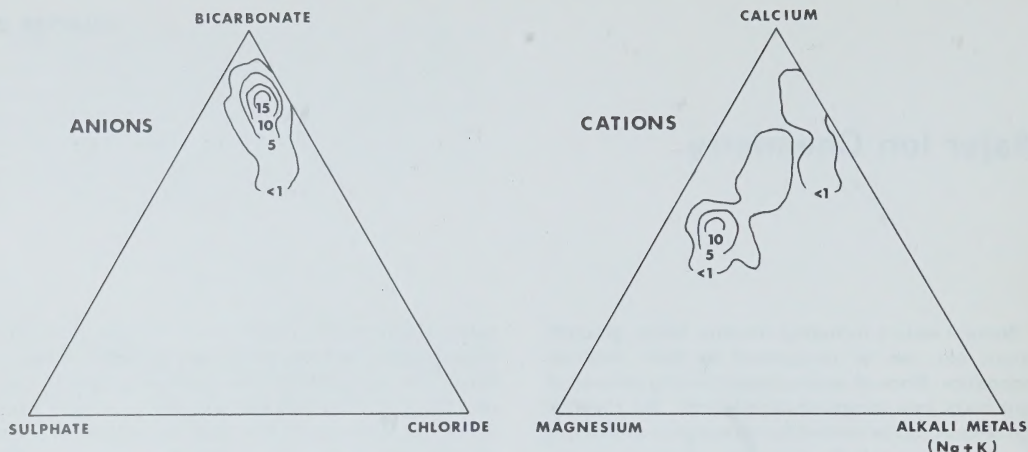


Figure 3. Major ion chemistry of Prince Edward Island groundwaters.

Although Figure 2 (Appendix IV) provides a graphic presentation of the chemical water types on Prince Edward Island, including their geographical distribution, the existence of a predominant type of groundwater is most clearly illustrated in Figure 3 (point density triangular diagram). The major ion chemistry data for the 32 groundwater stations have been plotted as relative equivalent proportions on either an ANION diagram (bicarbonate, sulphate, and chloride) or a CATION diagram (calcium, magnesium, and alkalies). The contours highlight the most common chemical compositions present in the groundwaters. The dominant type of anion was obviously bicarbonate, while the calcium-magnesium cation pair predominated over calcium alone. Thus the Prince Edward Island groundwater was primarily a calcium-magnesium bicarbonate water.

SALINE WATER

Estuaries

All the estuary stations (designated in orange, Figure 2, Appendix IV) exhibit the typical seawater dominance of sodium chloride with about 20 equivalent per cent of magnesium. The only exception to this standard composition is the Montague River station (01CE0002) which was probably influenced by dolomitic surface and sub-surface inputs from the surrounding drainage area into the estuary and thus the site exhibited a magnesium concentration in excess of 30 equivalent per cent.

Interparameter Relationships

All ground and surface waters on Prince Edward Island are of meteoric origin, that is derived from the atmosphere. Natural fresh waters are dilute solutions of alkali and alkaline earth metals, however the dissolution of materials in the drainage basin as well as the equilibria between percolating groundwater and the soil, surficial deposits and the bedrock may influence the ultimate chemical composition of the waters. Thus all natural waters will tend to exhibit well-defined chemical interrelationships. This section will deal with some of these observed (empirical) interrelationships for selected Prince Edward Island stations. The relationships were empirically derived and, therefore, are site-specific. The normal range of values encountered is large and only in a very general way may the relationships be applied to other sites. In order to empirically derive valid relationships

sufficient water quality data representing a full range of environmental conditions must be analyzed. An implicit assumption of this type of analysis is that during the time period of data collection the parametric interrelationships did not change and that they remain constant for any period of extrapolation of the interrelationship.

To assess whether the full range of environmental conditions have been sampled, one might consider (i) the sampling frequency and duration or (ii) the discharge (for stream stations) as key variables. Typically, the sampling frequency for the Prince Edward Island data set was monthly over a period of eight years during which more than 20 parameters were analyzed on each sample. Figure 4 compares the flow-duration curve generated

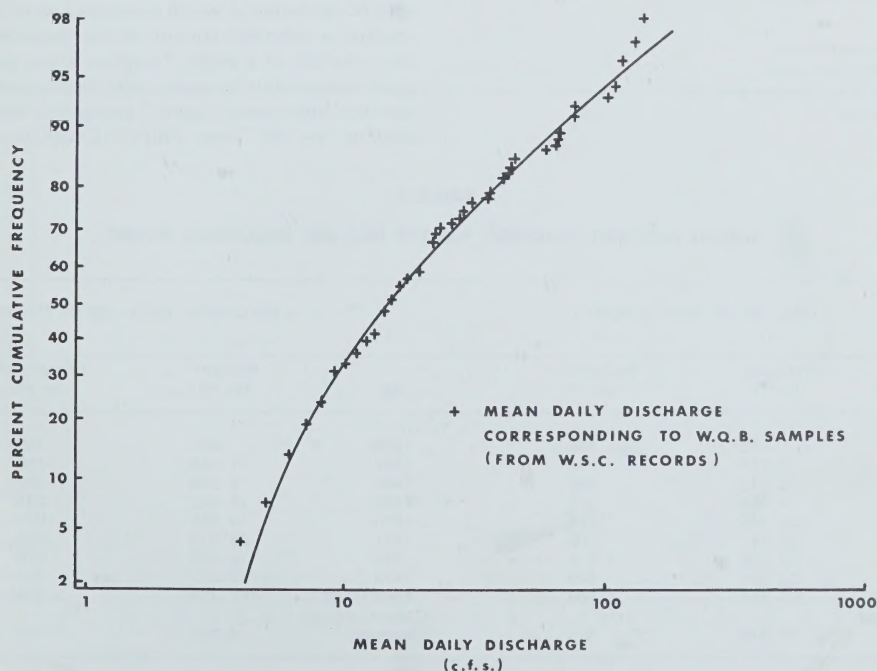


Figure 4. Flow-duration curve (1966-1973) for the Mill River with superposed discharge data corresponding to water quality sampling times.

from Water Survey of Canada data* (station 01CA003) with the mean daily discharge for those days on which a water quality sample was taken at the Mill River station, (00PE01CA0001). The excellent correspondence between the two data sets indicates that the full range of hydrologic conditions has been sampled at this site.

In flowing waters the dissolved chemical constituents, such as the major ions (TDS), exhibit a strong dependence on the discharge (Figure 5), whereas many of the parameters of greatest environmental concern (e.g. pesticides and heavy metals, including mercury) are more highly variable. Thus, unlike the dissolved major ions, their concentrations are non-predictive. Often these parameters are associated with the particulate phase rather than the dissolved phase, and their temporal concentration is dependent upon the vagaries of the suspended or particulate load in a water system. Other parameters such as the nutrients (nitrogen and phosphorus) undergo active biological transformations and, therefore, tend to be less predictive than the major ions. The highly variable nature of the non-conservative parameters is exemplified by Figure 6 (nitrogen versus

discharge). These parameters tend to be both temporally and spatially variable and as a result require sampling-intensive studies for their valid assessment.

Since the sampling frequency of the historical data base is typically monthly, only those parameters which can be adequately defined with this frequency of sampling will be considered in this section. Although nutrients, heavy metals, and pesticides cannot be adequately addressed, except for rough estimates of nutrient loadings to the estuaries, these parameters will be assessed under Section 4 by comparing their concentrations to prescribed guidelines for a number of water uses. Estimated nutrient loads (Table 1) to the estuaries were quite variable from year to year. The higher annual loading in the Mill River than in the Brudenell River, may be due to a slightly larger drainage area or more likely due to variations in agricultural practices on different soil types.

Total dissolved solids (TDS) is calculated from the major ions in solution and provides a measure of the freshwater salinity or ionic strength of a water. The specific conductance, which measures a water's ability to conduct an electrical current, is also dependent on the ionic strength of a water. Therefore, there should be a good relationship between total dissolved solids and specific conductance. Figure 7 exemplifies this relationship for the Mill River (00PE01CA0001). Thus the

* Enquiries should be sent to:

Director,
Water Resources Branch,
Inland Waters Directorate,
Department of the Environment,
Ottawa, Ontario,
K1A 0E7

TABLE 1
ANNUAL NUTRIENT LOADINGS* FOR THE MILL AND BRUDENELL RIVERS

MILL RIVER (00PE01CA0001)			BRUDENELL RIVER (00PE01CE0001)		
Year	Nitrogen (as N)	Phosphorus (as P)	Year	Nitrogen (as N)	Phosphorus (as P)
1966†	678	157	1966†	988	145
1967	10 277	512	1967	11 248	168
1968	2 313	284	1968	6 508	530
1969	14 654	115	1969	16 653	204
1970	20 305	768	1970	13 030	662
1971	22 341	506	1971	25 013	650
1972	17 309	1 775	1972	12 482	870
1973	25 681	849	1973	19 507	294
Total load‡	113 558	4 966	Total load‡	105 429	3 523
Mean annual loading	15 346	671	Mean annual loading	14 247	476

* kg/a - kilograms per annum

† August to December (5 months only)

‡ Time period 7.4 years

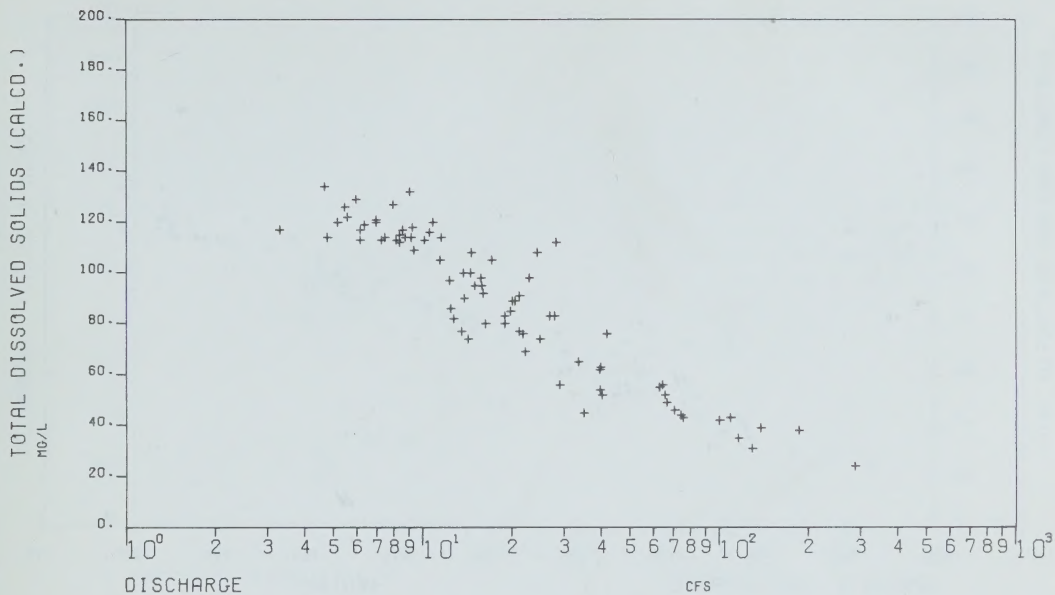


Figure 5. The discharge dependency of total dissolved solids at the Mill River site.

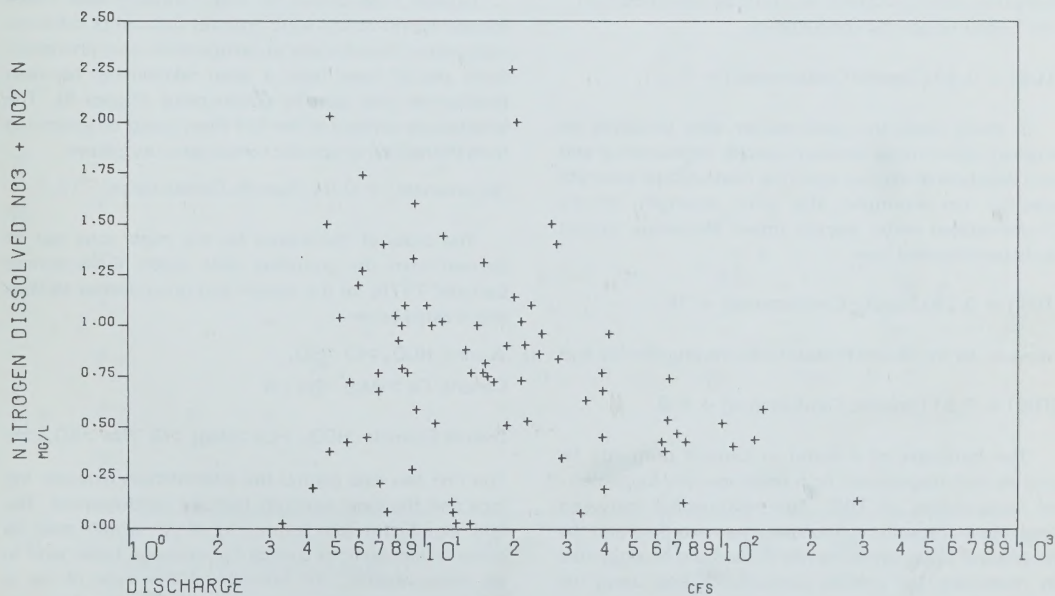


Figure 6. An example of the poor interdependency between non-conservative parameters (e.g. nitrogen) and discharge at the Mill River site.

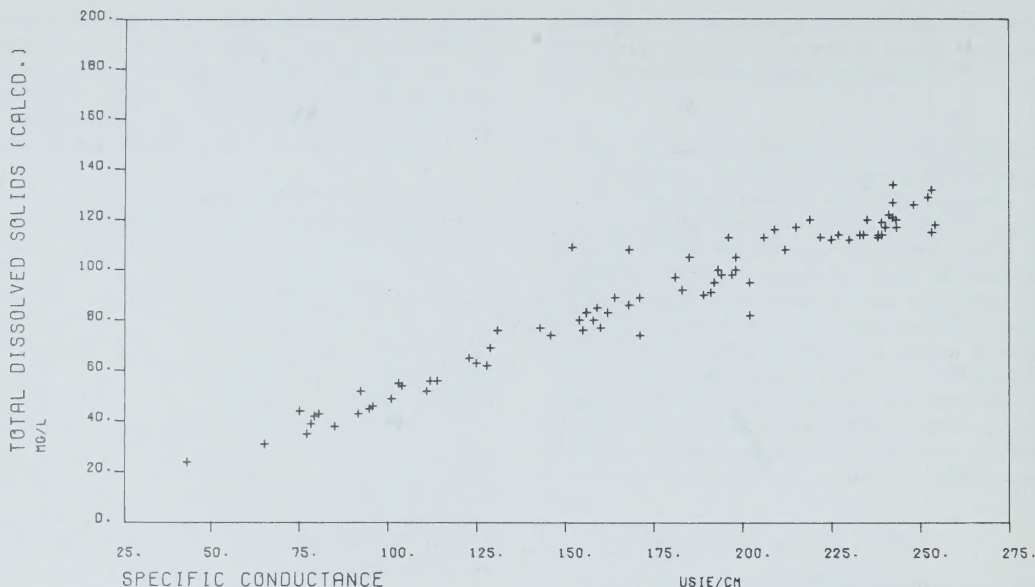


Figure 7. The interrelationship between total dissolved solids and specific conductance for Mill River.

freshwater salinity of Mill River could be estimated from the measured specific conductance,

$$[\text{TDS}] = 0.49 [\text{Specific Conductance}] + 4.$$

In many cases the groundwater sites exhibited an excellent relationship between specific conductance and total dissolved solids, but again the relationships were site specific. For example, the ionic strength of the Charlottetown water supply (main Malpeque pump) could be estimated from

$$[\text{TDS}] = 0.29 [\text{Specific Conductance}] + 76$$

whereas, for the Mount Pleasant well the relationship was

$$[\text{TDS}] = 0.51 [\text{Specific Conductance}] + 5.9$$

The hardness of a water is caused primarily by calcium and magnesium; both major ions are fundamental components of TDS. The relationship between hardness and specific conductance was excellent and the hardness of the water in the Mill River could be estimated by measuring the specific conductance and using the formula

$$[\text{Hardness}] = 0.50 [\text{Specific Conductance}] - 10$$

Figures 2 (Appendix IV) and 3 indicate that Prince Edward Island waters were typically calcium or calcium-magnesium bicarbonate in composition and, therefore, there should have been a good relationship between bicarbonate and specific conductance (Figure 8). The bicarbonate content of the Mill River could be estimated from the measured specific conductance as follows:

$$[\text{Bicarbonate}] = 0.54 [\text{Specific Conductance}] - 19.5$$

The order of dominance for the major ions can be derived from the summary data report (Environment Canada, 1976) for the stream and groundwater stations and is listed below:

Anions: $\text{HCO}_3 > \text{Cl} > \text{SO}_4$

Cations: $\text{Ca} > (\text{Mg})^* > \text{Na} > \text{K}$

Overall Estimate: $\text{HCO}_3 > \text{Ca} > (\text{Mg}) > \text{Cl} > \text{Na} > \text{SO}_4 > \text{K}$

The first few ions control the relationships between the ions and the ionic strength (specific conductance). The less significant ions especially those which may be derived from sources outside the drainage basin tend to be more variable. An example of this type of ion is sulphate, which is illustrated in Figure 9.

* Magnesium has a variable position in the catena, depending upon the water type.

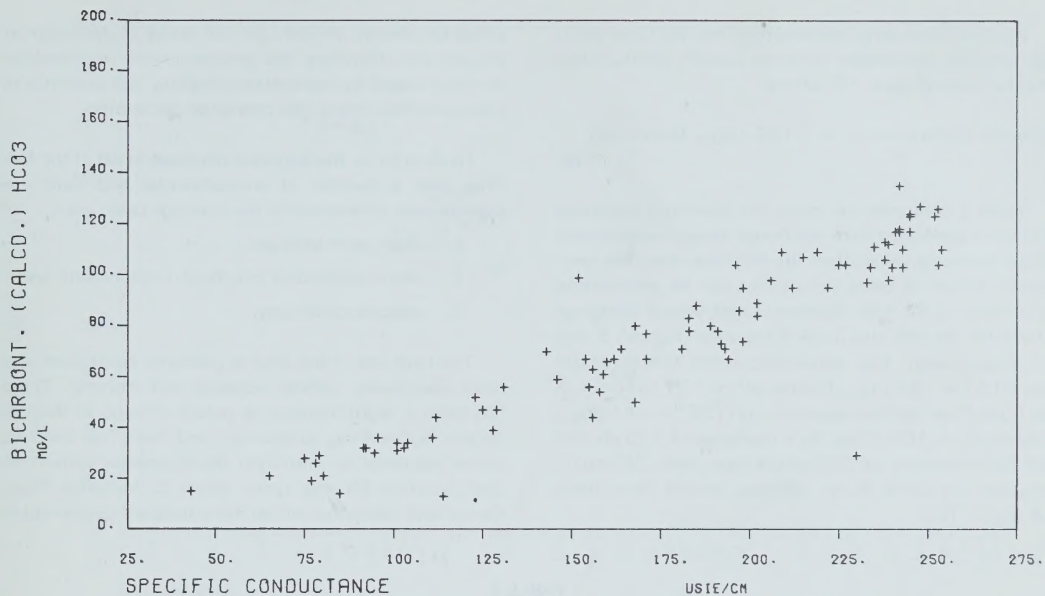


Figure 8. The bicarbonate-specific conductance interdependency in Mill River.

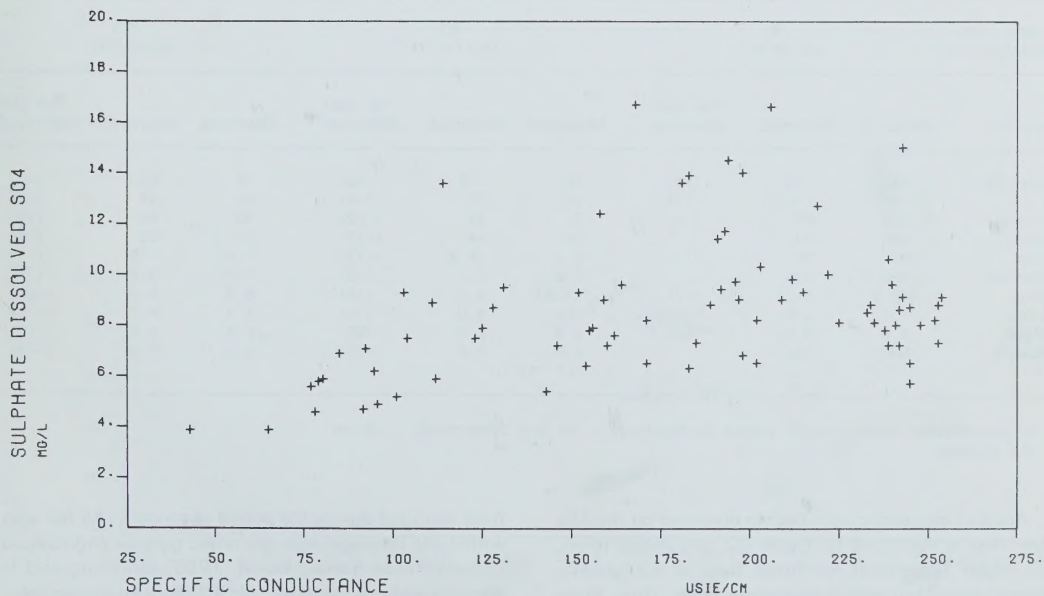


Figure 9. The sulphate-specific conductance interrelationship at the Mill River site.

Another interesting relationship at the Mill River site is the excellent correlation between specific conductance and discharge (Figure 10) where:

$$[\text{Specific Conductance}] = -126 [\log_{10} \text{Discharge}] + 335.$$

Table 2 compares the major ion chemistry estimates that were generated from discharge measurements with actual analytical values from the Mill River site. The site-specific nature of these calculations can be emphasized by comparing the total dissolved solids versus discharge curves for the Mill and Dunk River sites (Figures 5 and 11, respectively). The relationship at the Mill River site was $[\text{TDS}] = -64 [\log_{10} \text{Discharge}] + 171$, whereas at the Dunk River site the equation was $[\text{TDS}] = -41 [\log_{10} \text{Discharge}] + 160$. Thus, for a discharge of 120 cfs, the Mill River estimate of TDS would have been 38 mg/L, whereas the Dunk River estimate would have been 74 mg/L TDS.

schedule covered virtually the full range of discharge at the site and, therefore, the interparameter relationships were not biased by inadequate sampling, the existence of a temporal bias in the data cannot be discounted.

To account for the apparent decrease in pH at the Mill River site, a number of environmental and land use aspects were considered for the drainage basin area:

1. changes in land use;
2. municipal and/or industrial development; and
3. edaphic conditions.

The land use in the area is primarily agriculture and more specifically, potato cropping and dairying. There has been a slight increase in potato acreage in the last decade but nothing substantial, and there has been no active industrial or municipal developments within the past decade in the area, (pers. comm. C. Murphy). Thus, the cultural influences within the watershed appear not to

TABLE 2

A COMPARISON OF MEASURED MAJOR ION CHEMISTRY WITH ESTIMATES FROM DISCHARGE DATA AT THE MILL RIVER SITE *

Discharge and Observation Date	8 (03/10/67)			63 (05/11/72)			101 (02/05/71)		
	Measured	Estimated	Per cent difference	Measured	Estimated	Per cent difference	Measured	Estimated	Per cent difference
Conductivity	253	219	(13)	103	108	(-5)	79	83	(-5)
TDS	115	111	(3)	55	57	(-4)	42	44	(-5)
Bicarbonate	105	99	(6)	32	39	(-22)	30	25	(17)
Hardness	NA†	99		39	44	(-13)	31	32	(-3)
Calcium	28	25	(11)	9.2	10.8	(-17)	7.5	7.6	(-1)
Magnesium	NA†	9.8		3.8	4.1	(-8)	3.0	2.8	(7)
Chloride	10.4	11.1	(-7)	11.0	9.2	(16)	6.2	8.8	(-42)
Sodium	7.5	6.6	(12)	5.2	5.0	(4)	4.1	4.7	(-15)
Sulphate	8.8	9.5	(-8)	9.3	7.4	(20)	5.8	6.9	(-19)
Potassium	NA†	1.1		1.0	0.9	(10)	0.8	0.9	(-13)

* All concentration units - mg/L; except for Discharge - cfs and Conductivity - $\mu\text{S}/\text{cm}$

† Not available

Another interesting relationship observed on the Mill River data is illustrated by Figure 12 (pH versus time). The linear regression for these data is statistically different from zero with a decreasing slope. Thus, there may have been a decrease in excess of 0.5 pH unit at the Mill River site during the period of observation, 1966 to 1973. Although Figure 4 indicates that the sampling

have changed during the period of concern. All the soils within the drainage area are orthic podzols (Agriculture Canada/Prince Edward Island, 1965) exhibiting acid to strongly acid soil reactions (pH 4 to 6) with moderately-good to excessive drainage. The excessive nature of the surface runoff is borne out by the "flashy" hydrograph for the Mill River site (Figure 13).

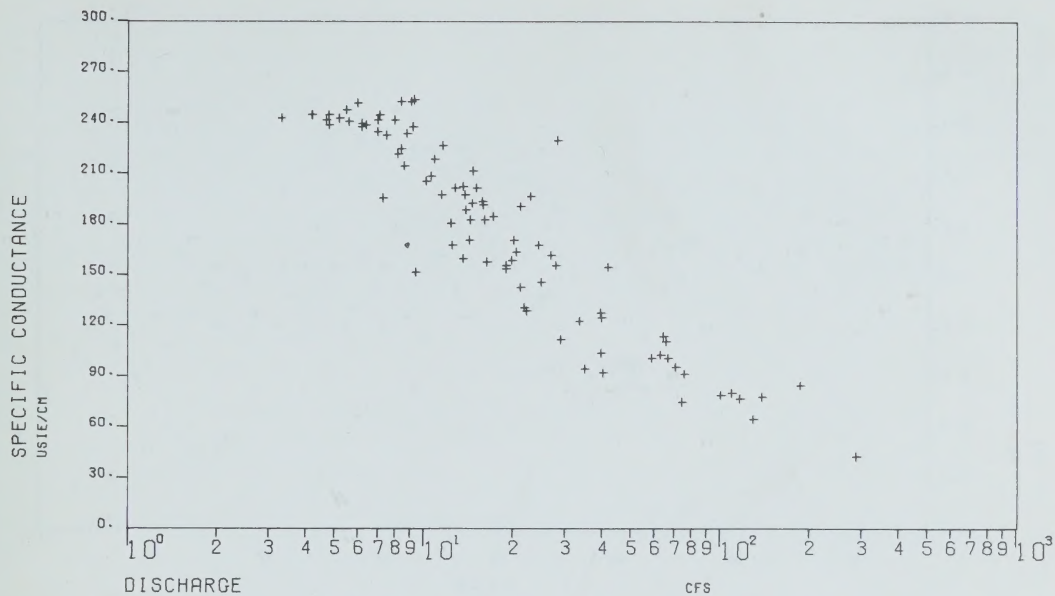


Figure 10. The discharge dependency of specific conductance at the Mill River site.

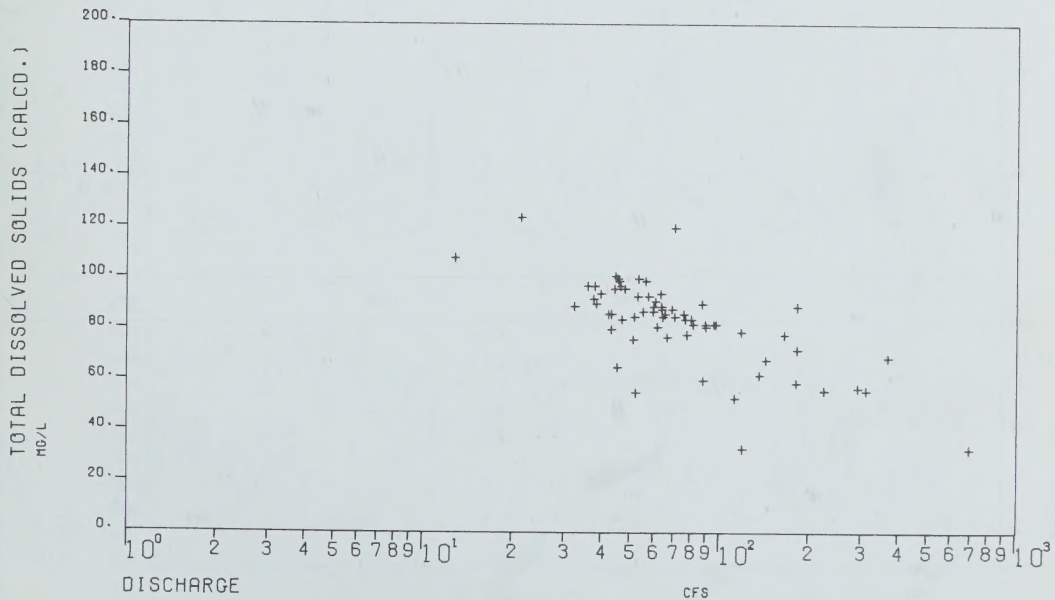


Figure 11. The total dissolved solids - discharge relationship on the Dunk River.

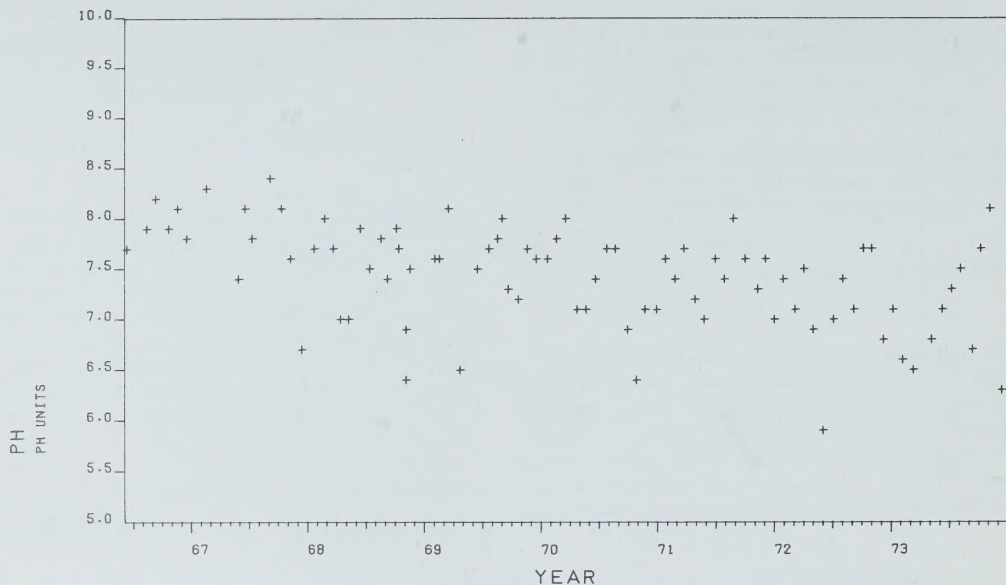


Figure 12. The pH change with time at the Mill River site.

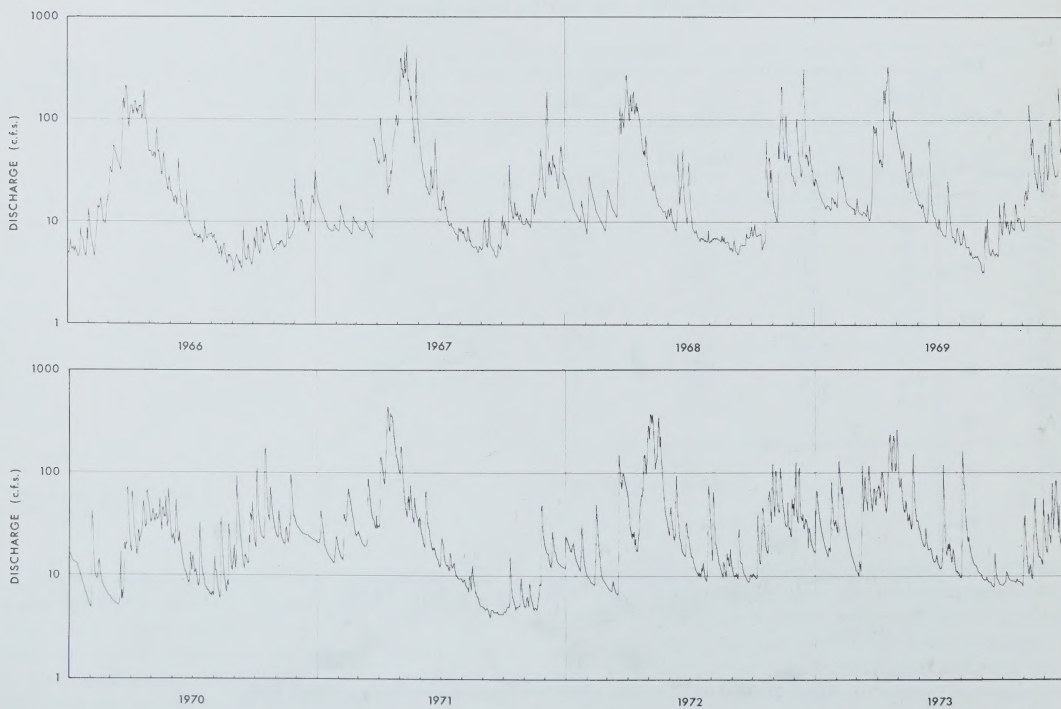


Figure 13. The Mill River hydrograph for 1966 to 1973 (from Water Survey of Canada records).

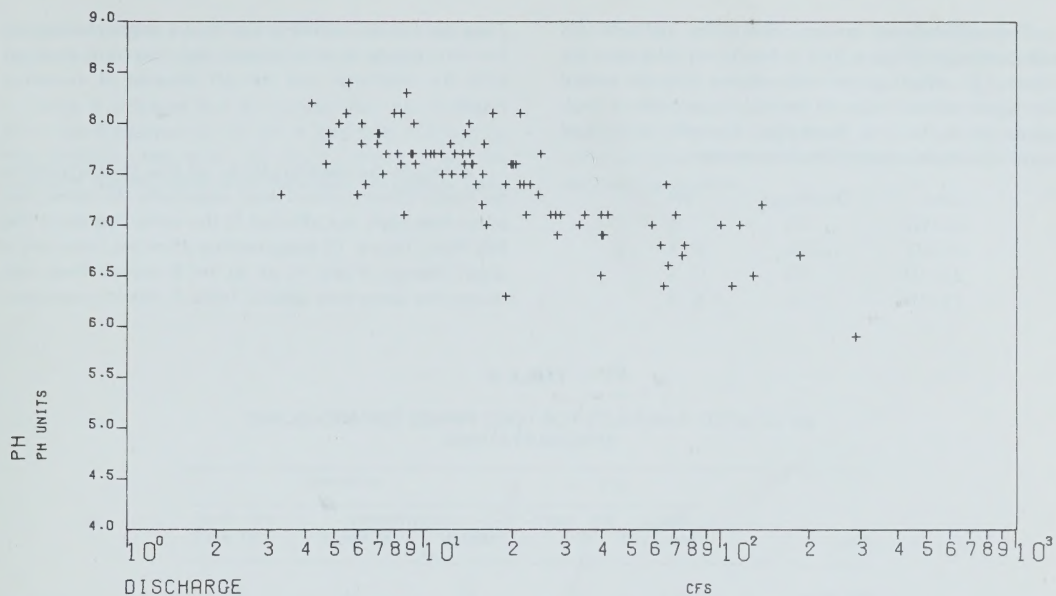


Figure 14. The inverse pH-discharge relationship at Mill River.

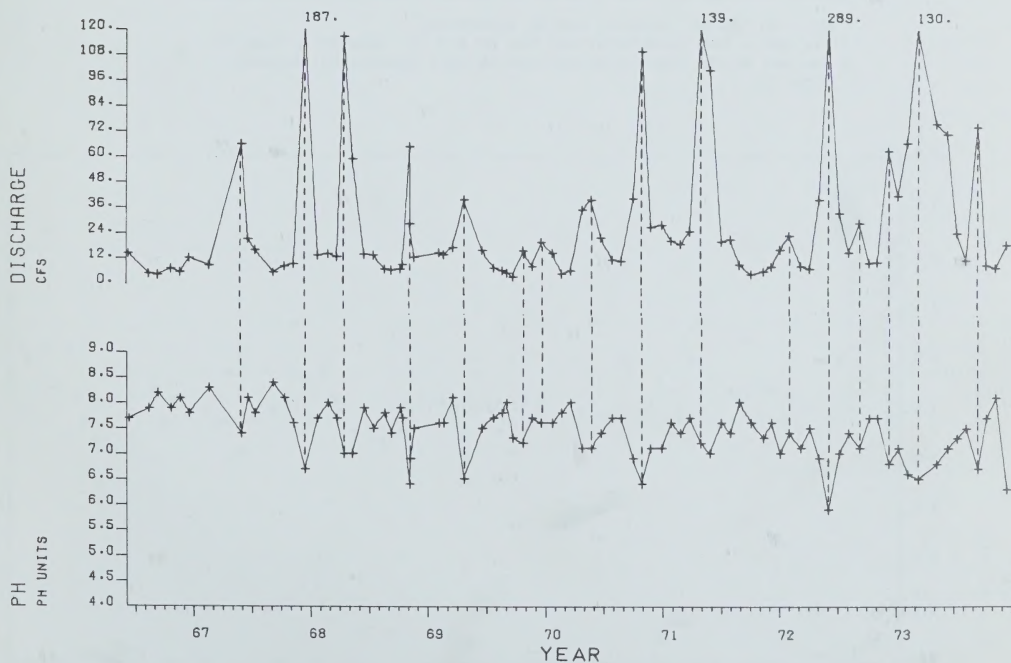


Figure 15. The temporal relationship between pH and discharge at the Mill River site.

The well-defined inverse relationship between pH and discharge (Figure 14) is further emphasized by Figure 15, which graphically shows the consistent downward inflection in pH caused by periods of high discharge at the Mill River site. As well, individual consecutive data support this phenomenon:

Date	Discharge	pH
03/03	23	7.4
05/03	220	6.1
22/10	65	6.4
23/10	28	6.9

Thus, the edaphic conditions in the drainage area allowed meteoric inputs to have a rapid and direct influence on both the discharge and the pH because of excessive runoff.

Although the median pHs for all four stream stations on Prince Edward Island were essentially the same, the other sites were not affected to the same degree as the Mill River. Figure 16 indicates that there has been only a slight change, if any, in pH at the Brudenell River site during the same time period. Table 3 allows a compari-

TABLE 3
pH RELATED VARIABLES FOR FOUR PRINCE EDWARD ISLAND
STREAM STATIONS

Site	pH		Alkalinity		
	Change 1966-1973	Per cent† <6.5	Concentration Median	1st decile	Per cent‡ <30 mg/L
Mill River	0.9	6	62	24	21
Dunk River	0.4	0	59	36	7
North Brook	NC*	3	74	58	7
Brudenell River	0.3	2	70	52	1

* NC - No Change; insufficient data for assessment

† Per cent of total observations less than pH 6.5 (cf. Appendix I, Table 50).

‡ Per cent of total observations less than 30 mg/L alkalinity (cf. Appendix I, Table 50).

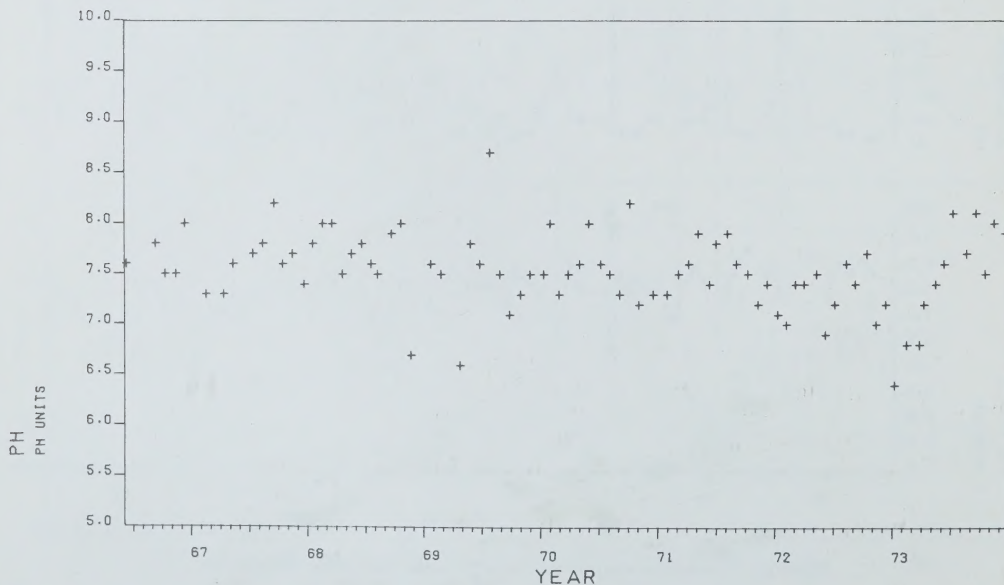


Figure 16. The pH versus time relationship at the Brudenell River site.

son of the variables pertinent to stream pH and buffering capacity of the waters for the four stream stations.

Table 3 indicates that the greater the "pH change", the more frequently (i) the pH is less than 6.5 and (ii) the alkalinity less than 30 mg/L. There is also an excellent inverse relationship between "pH change" and

the alkalinity concentration at the 1st decile level. Thus, the change in pH of certain Prince Edward Island surface waters appears to be related to the buffering capacity within the watershed and changes in discharge, although atmospheric deposition of acid aerosols would enhance these effects and should be addressed in future sampling programs.

Prince Edward Island Water Quality As Related to Specific-Use Guidelines

The chemical composition of water influences its suitability for specific applications and also affects the general condition of the aquatic environment and its biota. Five basic categories of water use can be identified:

1. domestic consumption (drinking water);
2. agricultural uses (livestock watering, crop irrigation);
3. industrial applications;
4. recreation; and
5. protection of aquatic life.

An assessment of the chemical composition of Prince Edward Island waters can be made using water quality objectives and guidelines. In order to meaningfully present the large amount of water quality data available and to relate the quality of the water to specific-use guidelines a computer program (Noncompliance*Analysis Program) has been written which compares the NAQUADAT (water quality) data to the levels of water quality desirable for specific uses. Annotated listings of the guidelines used in this report appear in Appendix I (Tables 31 to 45, inclusive). When a number of levels were prescribed in the literature for one water use, the *most stringent* level was selected for the analysis of the data. If a number of sources prescribed the same level, only the Canadian reference was noted in the tables. The levels recommended in these tables are subject to revision or adjustment as new and more significant information becomes available. Since there was insufficient microbiological data (e.g. coliform bacteria) on file, no assessment of the bacteriological suitability of the waters was made; but bacteriological information, especially for the shellfish areas, is available from the Environmental Protection Service, Fisheries and Environment Canada.

The program compares the numeric values for the various chemical constituents to the levels prescribed for a specific use. All the guideline levels are preceded by one of the following—GE, GT, LE, LT—where GE means greater than or equal to; GT means greater than; LE means less than or equal to; LT means less than. In

*Noncompliance is a term used to designate a result (datum) which is in nonobservance (e.g. in excess) of a specific water quality guideline.

analyzing the data there are four basic categories, namely (i) greater than (or equal to); (ii) less than (or equal to); (iii) a range; and (iv) "not detectable". These four categories are exemplified in Figure 17 by analyzing a hypothetical data set (columns 1 and 10). The detailed assessment for each of the hypothetical values appears in columns 3, 5, 7, and 9, in relation to the guidelines prescribed (columns 2, 4, 6, and 8, respectively). These values are then summarized as shown under "Summary Statistics" in Figure 17. This same procedure is used to produce the summary results presented in Tables 4 to 30.

Not all water quality parameters can be related to specific guidelines. In some cases *no guidelines* have been prescribed, whereas in other cases, the guideline is *outside the range of measurement* for the parameter and thus cannot be logically analyzed. Case I, which is the guideline for dissolved oxygen for the protection of freshwater aquatic life (Table 39), exemplifies this situation. The guideline level is "greater than or equal to 5.0", so that all values equal to or greater than 5.0 are in compliance and all values less than 5.0 are in noncompliance. All data values *above* the guideline level and qualified by an "L" cannot be related to the guideline of 5.0, since the real value may be less than, equal to, or greater than the 5.0 level, therefore, these values are *nonanalyzable* and are designated as "excluded" values in the tables. The same argument applies in reverse to the data values qualified by a "G". Any "G" value *below* a guideline level cannot be assessed in relation to the guideline, since the real value may be greater than, equal to, or less than the level prescribed. Thus nonanalyzable values appear in columns 3, 5, and 7.

Case II illustrates a prescribed range by using the pH guideline for the protection of freshwater aquatic life (Table 39). Compliances can only occur within the range prescribed. Noncompliances occur above and below the range, thus, two median values of the noncompliances may be shown in the summary tabulation.

Case III, the nitrate guideline for drinking water supplies (Table 33) emphasizes the subtle difference

Figure 17. Noncompliance Analysis of a Hypothetical Data Set. *

Hypothetical Data Set Values*	CASE I		CASE II		CASE III		CASE IV		Hypothetical Data Set Values*				
	Prescribed Level GE 5.0	Analysis of the Data†	Prescribed Level LE 9.0 GE 6.5	Analysis of the Data†	Prescribed Level LT 10.0	Analysis of the Data†	Prescribed Level ND	Analysis of the Data†					
G 12.0	IN COMPLIANCE	O	IN COMPLIANCE	X	IN COMPLIANCE	X	NOT DETECTABLE	X	G 12.0				
L 11.0		—		—		—		O	L 11.0				
10.0		O		X		X		X	10.0				
G 9.0		O		X		—		X	G 9.0				
8.0		O		O		O		X	8.0				
7.0		O		O		O		X	7.0				
L 6.0		—		X		O		O	L 6.0				
5.0		O		X		O		X	5.0				
G 4.0		—		—		—		X	G 4.0				
L 3.0		X		X		O		O	L 3.0				
SUMMARY OF STATISTICS													
Number of:													
Noncompliant Values (X)	1		6		2		7						
Included Values (X plus O)	7		8		7		10						
Excluded Values (—)	3		2		3		0						
Median of Noncompliant Values	3.0		10.0 [3] ‡ 5.0 [3] ‡		11.0		8.0 (3.0) ‡						

* In a data set G means "greater than"; L means "less than."

† O means "in compliance"; X means "in noncompliance"; — means "nonanalyzable" (thus excluded)

‡ [] is the number of noncompliant values considered; () is the detection limit of the method.

between an "LE" and an "LT" guideline. All real values and values qualified by an "L" that are less than 10.0 are in compliance, but the real value of 10.0 is in noncompliance, since the guideline stipulates (*less than*) LT 10.0.

Case IV illustrates the logical decision made by the program when a "not detectable" guideline is prescribed. Only those values that are qualified by an "L" are in compliance; all other values are in noncompliance regardless of qualifier. One would not expect to have such divergent detection limits as L3.0, L6.0, and L11.0 in a real data set; usually only one detection limit is encountered.

This type of analysis emphasizes the noncompliances. As indicated in Figure 17, the summary tables (Tables 4 to 30) tabulate the number of noncompliances, the number of included (noncompliant plus compliant) values and the number of excluded (nonanalyzable) values. The numeric values of the noncompliances for each parameter

are noted and the median value of the noncompliances is presented in the last column of these tables. The magnitude of the difference between the prescribed level and this median value allows an assessment of the degree of severity of the noncompliances when the merits of the parameter in question are also considered. The discussions will highlight only those parameters which are in nonobservance of particular water quality guidelines. In addition to the summary tables in the text, tables listing the parameter(s) assessed in analyzing a particular data set and tables listing the number of noncompliances, in detail, at each station appear in Appendix I (Tables 46 to 94).

Only parameters available on the data base can be analyzed and thus all of the parameters relevant to a specific use may *not* be assessed in this report due to a lack of data, since the sampling programs were not designed to determine compliance with specific use guidelines.

The various water types (e.g. stream, groundwater, estuary) can be used for a number of purposes and the assessment of their suitability can be related to guidelines specified for those uses. River waters have the greatest potential range of uses involving all five of the basic categories, whereas it would be inappropriate to assess the chemical composition of estuaries in terms of domestic consumption. Nine of the 32 wells sampled were water level monitoring wells which were not actively pumped on a regular basis. Therefore they may have exhibited anomalously high values for parameters such as turbidity, colour and possibly metals because of sediment accumulations in the wells. The water quality data from these wells (cf. Appendix III) should be interpreted with caution.

DOMESTIC CONSUMPTION

Both stream and groundwater can be used as drinking water sources. The most meaningful interpretation of the data in relation to raw water sources for drinking water is achieved by considering three guideline levels: maximum permissible, acceptable, and objective levels. The observed noncompliances with the guideline levels (e.g. Table 5) indicate that treatment of the water(s) may have been required prior to use, depending on the severity of the noncompliances.

Maximum Permissible Levels

These levels are *standards*. The term standard is used for levels of certain substances that are known or suspected to be linked with human health (e.g. toxic

chemicals, radioactive substances, pathogenic organisms). The levels in each case, if exceeded, shall be sufficient grounds for the rejection of the water supply unless effective remedial treatment is applied to either totally remove the particular substance or to bring it to a concentration below the tabulated level. Substances in this category, when present in concentrations above the indicated values, have been associated with adverse effects on human health. Lesser concentrations, therefore, are desirable and no water supply should be permitted to carry these chemicals at the indicated levels continuously (Nat. Health & Welfare, 1969).

None of the parameters measured on the stream water samples exceeded the maximum permissible guidelines (Table 4), whereas 27 per cent of the groundwater samples analyzed for lead exceeded the guideline and approximately 2 per cent of the samples analyzed for nitrate plus nitrite slightly exceeded the guideline (Table 5).

Acceptable Levels

These levels should not be exceeded whenever more suitable supplies are, or can be made, available within the technological and economic resources of the community. Substances in this category, when present in concentrations above the indicated limits, are either objectionable to a significant number of people or capable of producing deleterious health or other effects. Any water supply, when exceeding the acceptable levels in one or more of the quality characteristics, should be assessed on its individual merits as to its suitability and safety from health, aesthetic, and other viewpoints (Nat. Health & Welfare, 1969).

TABLE 4
SUMMARY RESULTS
COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
MAXIMUM PERMISSIBLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
FLUORIDE, As F ⁻	LE	1.5	mg/L	0	20	0	
LEAD, As Pb	LE	0.05	mg/L	0	45	0	
NITRATE + NITRITE, As N	LE	10.0	mg/L	0	271	0	
TOTAL				0	336	0	

TABLE 5
SUMMARY RESULTS
COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
MAXIMUM PERMISSIBLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
CADMIUM, As Cd	LE	0.01	mg/L	1	139	0	0.012
FLUORIDE, As F ⁻	LE	1.5	mg/L	0	135	0	
LEAD, As Pb	LE	0.05	mg/L	36	132	0	
NITRATE + NITRITE, As N	LE	10.0	mg/L	5	335	0	
TOTAL				42	741	0	

Since the acceptable levels are more stringent than the maximum permissible levels, both stream and groundwater samples exhibited noncompliances (Tables 6 and 7, respectively). Thirty-six per cent of the stream water samples analyzed had colour values greatly in excess of the guideline; 19 per cent of the samples had

excess turbidity; and about 10 per cent of the alkalinity values were slightly below the range of 30 to 500 mg/L. Only about 3 per cent of the samples failed to comply with the pH range of 6.5 to 8.3. Seven per cent of the ammonia results were slightly greater than the guideline, whereas less than 3 per cent of the phosphorus results

TABLE 6
SUMMARY RESULTS
COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
ACCEPTABLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALKALINITY, As CaCO ₃	GE	30	mg/L	26	269	0	25
	LE	500	mg/L				
AMMONIA, As N	LE	0.5	mg/L	4	57	0	0.6
CALCIUM, As Ca	LE	200	mg/L	0	264	0	
CHLORIDE, As Cl ⁻	LE	250	mg/L	0	272	0	
COLOUR	LE	15	TCU	99	273	0	30
COPPER, As Cu	LE	1.0	mg/L	0	44	0	
FLUORIDE, As F ⁻	LE	1.4	mg/L	0	20	0	
HARDNESS, TOTAL, As CaCO ₃	LT	500.0	mg/L	0	130	0	
IRON, DISSOLVED, As Fe	LE	0.3	mg/L	0	64	0	
LEAD, As Pb	LT	0.05	mg/L	0	45	0	
MAGNESIUM, As Mg	LE	150	mg/L	0	101	0	
NITRATE + NITRITE, As N	LT	10.0	mg/L	0	271	0	
pH	GE	6.5		8	270	0	6.4 [6]
	LE	8.3					8.6 [2]
PHOSPHORUS, TOT.INORG., As P	LE	0.2	mg/L	2	86	0	1.8
SULPHATE, As SO ₄ ²⁻	LE	500	mg/L	0	242	0	
TOTAL DISSOLVED SOLIDS	LE	1000	mg/L	0	255	0	
TURBIDITY	LE	5	JTU	52	274	0	10
ZINC, As Zn	LE	5.0	mg/L	0	43	0	
TOTAL				191	2980	0	

[] - Number of values

TABLE 7

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
ACCEPTABLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALKALINITY, As CaCO_3	GE	30	mg/L	4	335	0	7
	LE	500	mg/L				
AMMONIA, As N	LE	0.5	mg/L	0	109	0	
CADMIUM, As Cd	LT	0.01	mg/L	1	139	0	0.012
CALCIUM, As Ca	LE	200	mg/L	0	333	0	
CHLORIDE, As Cl^-	LE	250	mg/L	0	334	0	
COLOUR	LE	15	TCU	23	220	0	60
COPPER, As Cu	LE	1.0	mg/L	0	110	0	
FLUORIDE, As F^-	LE	1.4	mg/L	0	135	0	
HARDNESS, TOTAL, As CaCO_3	LT	500.0	mg/L	0	331	0	
IRON, DISSOLVED, As Fe	LE	0.3	mg/L	0	101	0	
LEAD, As Pb	LT	0.05	mg/L	37	132	0	0.068
MAGNESIUM, As Mg	LE	150	mg/L	0	334	0	
MANGANESE, As Mn	LE	0.05	mg/L	3	58	0	0.07
NITRATE + NITRITE, As N	LT	10.0	mg/L	6	335	0	10.4
pH	GE	6.5		6	336	0	6.3 [5]
	LE	8.3					8.4 [1]
PHOSPHORUS, TOT.INORG., As P	LE	0.2	mg/L	9	212	0	0.23
SULPHATE, As SO_4^{2-}	LE	500	mg/L	0	217	0	
TOTAL DISSOLVED SOLIDS	LE	1000	mg/L	0	211	0	
TURBIDITY	LE	5	JTU	98	218	0	36
ZINC, As Zn	LE	5.0	mg/L	0	67	0	
TOTAL				187	4267	0	

[] - Number of values

were considerably higher than acceptable at the Mill River site. Mill River exhibited the greatest percentage of noncompliances for all parameters assessed.

Although more parameters exhibited noncompliances in the groundwater than in the stream water data (9 and 6, respectively) fewer overall noncompliances were observed on the groundwater data (5 versus 7 per cent). Forty-five per cent of the turbidity results were in noncompliance and 28 per cent of the samples analyzed for lead were slightly in excess of the guideline. Slightly more than 10 per cent of the samples exhibited excessive colour. About 5 per cent of the manganese values were above the guideline in the Bloomfield Station, St. Charles Station, and Lower Montague wells and 4 per cent of the phosphorus concentrations were very slightly in excess of 0.2 mg/L in seven wells. Minor noncompliances also occurred for pH and alkalinity. Fifty per cent of the water samples from the Mount Carmel well were in excess of 10 mg/L nitrate-N, whereas the other noncompliances were single occurrences only. One sample out of nine at

the St. Charles Station well exhibited a cadmium concentration in excess of the guideline.

Objective Levels

These levels should be interpreted as the long-term quality goal to be reached. It is implied that water supplies which meet these requirements are of very good and safe quality from health, aesthetic, and other viewpoints (Nat. Health and Welfare, 1969).

All of the ammonia results on stream water data that were above the detection limit of the analytical method used were in noncompliance with the objective level, however, about 40 per cent of the samples were excluded from mathematical analysis because the detection limit of the method (0.05 mg/L) was above the guideline prescribed (Table 8). Again, turbidity and colour exhibited frequent noncompliances (72 and 59 per cent, respectively). Lead contravened the guideline on 69 per

TABLE 8

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
OBJECTIVE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL		NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
			NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
AMMONIA, As N	LE	0.01 mg/L	35	35	22	0.15
CALCIUM, As Ca	LT	75 mg/L	1	264	0	76
CHLORIDE, As Cl ⁻	LT	250 mg/L	0	272	0	
COLOUR	LE	5 TCU	161	273	0	18
COPPER, As Cu	LT	0.01 mg/L	6	44	0	0.04
FLUORIDE, As F ⁻	LT	1.2 mg/L	0	20	0	
HARDNESS, TOTAL, As CaCO ₃	LT	120 mg/L	0	130	0	
IRON, DISSOLVED, As Fe	LT	0.05 mg/L	21	64	0	0.07
LEAD, As Pb		ND mg/L	31	45	0	0.003 (0.001)
MAGNESIUM, As Mg	LT	50 mg/L	0	101	0	
NITRATE + NITRITE, As N	LT	10.0 mg/L	0	271	0	
PHOSPHORUS, TOT.INORG., As P	LT	0.2 mg/L	2	86	0	0.22
SULPHATE, As SO ₄ ²⁻	LT	250 mg/L	0	242	0	
TOTAL DISSOLVED SOLIDS	LT	500 mg/L	0	255	0	
TURBIDITY	LE	1 JTU	197	274	0	2.9
ZINC, As Zn	LT	1.0 mg/L	0	43	0	
TOTAL			454	2419	22	

() - Level of Detection Limit

cent of the water samples. Noncompliances for both iron and copper at all sites were very evident (33 and 14 per cent, respectively), and one calcium result happened to be greater than the guideline of 75 mg/L at the Dunk River site and two samples for phosphorus at the Mill River site were slightly in excess of the guideline. A similarly large increase in the frequency of noncompliances occurred when comparing the groundwater data with the stringent objective levels (Table 33, Appendix I). Again all the included ammonia values (Table 9) were well in excess of the guideline and approximately 88 per cent of the samples were excluded. Over half the water samples analyzed for turbidity were in noncompliance and although Prince Edward Island groundwaters were classified as moderately soft, 40 per cent of the hardness results in nine wells were slightly above the guideline. The metals—lead, copper, cadmium, and manganese—all exhibited frequent noncompliances (83, 63, 26, and 16 per cent, respectively), whereas the guideline for iron was contravened on only 3 per cent of the water samples taken from the Auburn and Georgetown wells. In contrast to ammonia, the other plant nutrients—phosphorus and nitrate, were in minor noncompliance rather infrequently (5 and 2 per cent, respectively).

In summary, some of the Prince Edward Island waters assessed would require at least minimal treatment prior to use for domestic consumption. The parameters of most concern are the metals (especially lead), ammonia, and to a lesser extent turbidity, colour, and hardness. The high frequency of metal noncompliances in the groundwater samples does not necessarily indicate that the aquifers contained high metal concentrations. The metal concentrations may have been derived from the storage and distribution systems from which the samples were collected. Most groundwaters in Prince Edward Island were slightly corrosive (Table 10) and may have caused the dissolution of copper, iron, and lead from metal pipes and tanks. Thirty-five per cent of the saturation index values are less than -0.75, which is indicative of corrosive waters. The stream waters would appear to have been more highly coloured than the groundwaters, whereas excessive turbidity frequently occurred in both stream and groundwater samples. The ammonia guideline was frequently exceeded at nine well sites and all four stream sites, which suggests that agricultural or site-specific waste disposal may have been responsible for these noncompliances. The hardness guideline was exceeded by water samples taken in all areas except the western portion of the province.

TABLE 9

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *GROUNDWATER* DATA IN RELATION TO
OBJECTIVE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
AMMONIA, As N	LE	0.01	mg/L	13	13	96	0.13
CADMIUM, As Cd		ND	mg/L	34	139	0	0.001 (0.001)
CALCIUM, As Ca	LT	75	mg/L	3	333	0	80
CHLORIDE, As Cl ⁻	LT	250	mg/L	0	334	0	
COLOUR	LE	5	TCU	38	220	0	17
COPPER, As Cu	LT	0.01	mg/L	69	110	0	0.07
FLUORIDE, As F ⁻	LT	1.2	mg/L	0	135	0	
HARDNESS, TOTAL, As CaCO ₃	LT	120	mg/L	134	331	0	150
IRON, DISSOLVED, As Fe	LT	0.05	mg/L	3	101	0	0.06
LEAD, As Pb		ND	mg/L	109	132	0	0.023 (0.001)
MAGNESIUM, As Mg	LT	50	mg/L	0	334	0	
MANGANESE, As Mn	LT	0.01	mg/L	9	58	0	0.02
NITRATE + NITRITE, As N	LT	10.0	mg/L	6	335	0	10.4
PHOSPHORUS, TOT.INORG., As P	LT	0.2	mg/L	11	212	0	0.22
SULPHATE, As SO ₄ ²⁻	LT	250	mg/L	0	217	0	
TOTAL DISSOLVED SOLIDS	LT	500	mg/L	0	211	0	
TURBIDITY	LE	1	JTU	121	218	0	25
ZINC, As Zn	LT	1.0	mg/L	0	67	0	
TOTAL				550	3500	96	

() - Level of Detection Limit

TABLE 10

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *GROUNDWATER* DATA IN RELATION TO
THE SATURATION INDEX

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
SATURATION INDEX	GE	-0.75		74	210	0	-1.05
TOTAL				74	210	0	

AGRICULTURAL USES

Irrigation on Acid Soils

Livestock Watering

In relation to the seven parameters assessed, the stream waters from the Mill, Dunk, and Brudenell Rivers and North Brook were suitable for direct livestock watering (Table 11). Only two noncompliances occurred for lead (Auburn Well) in the approximately 1500 analyses for eight parameters on the groundwater samples (Table 12).

The stream waters were suitable for direct crop irrigation in relation to the six parameters assessed (Table 13), whereas very minor noncompliances for iron (Mount Pleasant, Bloomfield Station, and Kensington Wells), manganese (Lower Montague), copper (Auburn and St. Charles Station Wells), and cadmium (St. Charles Station Well) occurred on the groundwater samples (Table 14). These noncompliances were probably not serious enough to require treatment of the waters prior to use judging from the medians of the noncompliant values.

TABLE 11
SUMMARY RESULTS
COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
GUIDELINES FOR LIVESTOCK WATERING

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
CALCIUM, As Ca	LE	1000	mg/L	0	264	0	
COPPER, As Cu	LE	0.5	mg/L	0	44	0	
LEAD, As Pb	LE	0.1	mg/L	0	45	0	
NITRATE + NITRITE, As N	LE	100	mg/L	0	271	0	
SULPHATE, As SO ₄	LE	1000	mg/L	0	242	0	
ZINC, As Zn	LE	25	mg/L	0	43	0	
TOTAL				0	909	0	

TABLE 12
SUMMARY RESULTS
COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
GUIDELINES FOR LIVESTOCK WATERING

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
CADMIUM, As Cd	LE	0.050	mg/L	0	139	0	
CALCIUM, As Ca	LE	1000	mg/L	0	333	0	
COPPER, As Cu	LE	0.5	mg/L	0	110	0	
FLUORIDE, As F ⁻	LE	2.0	mg/L	0	135	0	
LEAD, As Pb	LE	0.1	mg/L	2	132	0	0.8
NITRATE + NITRITE, As N	LE	100	mg/L	0	335	0	
SULPHATE, As SO ₄	LE	1000	mg/L	0	217	0	
ZINC, As Zn	LE	25	mg/L	0	67	0	
TOTAL				2	1468	0	

TABLE 13

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *STREAM WATER* DATA IN RELATION TO
GUIDELINES FOR IRRIGATION OF ACIDIC SOILS

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
COPPER, As Cu	LE	0.20	mg/L	0	44	0	
IRON, As Fe	LE	5.0	mg/L	0	93	0	
LEAD, As Pb	LE	5.0	mg/L	0	45	0	
pH	GE	4.5		0	270	0	
	LE	9.0					
SODIUM ABSORPTION RATIO	LT	8		0	259	0	
ZINC, As Zn	LE	2.0	mg/L	0	43	0	
TOTAL				0	754	0	

TABLE 14

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *GROUNDWATER* DATA IN RELATION TO
GUIDELINES FOR IRRIGATION OF ACIDIC SOILS

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
CADMIUM, As Cd	LE	0.010	mg/L	1	139	0	0.012
COPPER, As Cu	LE	0.20	mg/L	2	110	0	0.33
FLUORIDE, As F ⁻	LE	1.0	mg/L	0	135	0	
IRON, As Fe	LE	5.0	mg/L	4	129	0	7.7
LEAD, As Pb	LE	5.0	mg/L	0	132	0	
MANGANESE, As Mn	LE	0.20	mg/L	1	58	0	0.28
pH	GE	4.5		0	336	0	
	LE	9.0					
SODIUM ABSORPTION RATIO	LT	8		0	330	0	
ZINC, As Zn	LE	2.0	mg/L	0	67	0	
TOTAL				8	1436	0	

The direct use of both stream and groundwater for livestock watering and irrigation should have posed no serious problems in Prince Edward Island.

INDUSTRIAL USES

Food Processing

An analysis of the stream water data for 12 parameters of concern to the food processing industry (Table 15) indicated that more than 95 per cent of the samples analysed for turbidity were in excess of the "not detectable" limit and slightly more than 40 per cent of the samples analyzed for suspended solids and iron exceeded their guidelines. The iron noncompliances were minor with a median level of 0.29 mg/L, which is only 0.09 mg/L above the prescribed guideline. Less than 3 per cent of the samples contravened the pH guideline.

As with the stream water samples, approximately 14 per cent of the groundwater samples analyzed exceeded the guidelines prescribed (Table 37, Appendix I). All of the groundwater samples analyzed (Table 16) had suspended solids concentrations in excess of 10 mg/L and 85 per cent of the samples had excessive turbidity. The guideline for iron was exceeded by 40 per cent of the

samples with a median concentration of the noncompliances three times the guideline level. About 20 per cent of the hardness and alkalinity values were in noncompliance but less than 2 per cent of the pH (Meadow Bank, Hunter River, St. Charles Station, and Lower Montague wells), nitrate (Mount Carmel, Lower Montague, and Cardigan wells), and manganese (Lower Montague well) analyses contravened the guidelines specified.

Electrical Power Generation

High-pressure steam generation requires very high quality feedwater as indicated by Table 38 (Appendix I). Most waters, including Prince Edward Island stream and groundwaters, require treatment for this application. Tables 17 and 18 indicate that all 12 parameters measured, except for copper, zinc, and manganese, contravened the guidelines on virtually all of the samples at all sites.

RECREATIONAL USES

Since the recreational suitability of a water is dependent more on bacteriological and aesthetic considerations rather than a water's chemical constituents no attempt will be made in this report to assess the Prince Edward Island data in relation to recreational use.

TABLE 15
SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *STREAM WATER* DATA IN RELATION TO
GUIDELINES FOR FOOD PROCESSING INDUSTRIES

PARAMETER	LEVEL		NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
			NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALKALINITY, As CaCO ₃	LE	150	mg/L	0	269	0
CHLORIDE, As Cl ⁻	LE	250	mg/L	0	272	0
FLUORIDE, As F ⁻	LE	1	mg/L	0	20	0
HARDNESS, As CaCO ₃	LE	150	mg/L	0	130	0
IRON, As Fe	LE	0.2	mg/L	38	93	0
NITRATE, As N	LE	10	mg/L	0	271	0
pH	GE	6.5		7	270	0
	LE	8.5				6.3 [6] 8.7 [1]
SILICA, As SiO ₂	LE	50	mg/L	0	271	0
SULPHATE, As SO ₄ ²⁻	LE	250	mg/L	0	242	0
SUSPENDED SOLIDS	LE	10	mg/L	13	31	0
TOTAL DISSOLVED SOLIDS	LE	500	mg/L	0	255	0
TURBIDITY	ND	JTU		263	274	0
TOTAL				321	2398	0

[] - Number of values

TABLE 16

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
GUIDELINES FOR FOOD PROCESSING INDUSTRIES

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON-COMPLIANT VALUES
				NON-COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALKALINITY, As CaCO_3	LE	150	mg/L	56	335	0	208
CHLORIDE, As Cl^-	LE	250	mg/L	0	334	0	
FLUORIDE, As F^-	LE	1	mg/L	0	135	0	
HARDNESS, As CaCO_3	LE	150	mg/L	67	331	0	168
IRON, As Fe	LE	0.2	mg/L	52	129	0	0.64
MANGANESE, As Mn	LE	0.2	mg/L	1	58	0	0.28
NITRATE, As N	LE	10	mg/L	5	335	0	10.5
pH	GE	6.5		5	336	0	6.3 [5]
	LE	8.5					
SILICA, As SiO_2	LE	50	mg/L	0	217	0	
SULPHATE, As SO_4^{2-}	LE	250	mg/L	0	217	0	
SUSPENDED SOLIDS	LE	10	mg/L	30	30	0	77
TOTAL DISSOLVED SOLIDS	LE	500	mg/L	0	211	0	
TURBIDITY		ND	JTU	186	218	0	7.5
TOTAL				402	2886	0	

[] - Number of values

TABLE 17

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
GUIDELINES FOR ELECTRICAL UTILITIES (HIGH PRESSURE STEAM GENERATION)

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON-COMPLIANT VALUES
				NON-COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALKALINITY, As CaCO_3	LE	1	mg/L	269	269	0	66
BICARBONATE, As HCO_3^-	LE	0.5	mg/L	269	269	0	81
CALCIUM, As Ca	LE	0.01	mg/L	264	264	0	20
COPPER, As Cu	LE	0.01	mg/L	6	44	0	0.04
HARDNESS, TOTAL, As CaCO_3	LE	0.07	mg/L	130	130	0	84
IRON, As Fe	LE	0.01	mg/L	87	93	0	0.19
MAGNESIUM, As Mg	LE	0.01	mg/L	101	101	0	4.7
pH	GE	8.8		270	270	0	7.46
	LE	9.4					
SUSPENDED SOLIDS	LE	0.05	mg/L	29	29	2	9.3
TOTAL DISSOLVED SOLIDS	LE	0.5	mg/L	255	255	0	92
ZINC, As Zn	LE	0.01	mg/L	15	43	0	0.02
TOTAL				1695	1767	2	

TABLE 18

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
GUIDELINES FOR ELECTRICAL UTILITIES (HIGH PRESSURE STEAM GENERATION)

PARAMETER	LEVEL	NUMBER OF			MEDIAN OF NON-COMPLIANT VALUES		
		NON-COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES			
ALKALINITY, As CaCO ₃	LE	1	mg/L	335	335	0	103
BICARBONATE, As HCO ₃	LE	0.5	mg/L	335	335	0	126
CALCIUM, As Ca	LE	0.01	mg/L	333	333	0	27
COPPER, As Cu	LE	0.01	mg/L	66	110	0	0.07
HARDNESS, TOTAL, As CaCO ₃	LE	0.07	mg/L	331	331	0	110
IRON, As Fe	LE	0.01	mg/L	124	129	0	0.12
MAGNESIUM, As Mg	LE	0.01	mg/L	334	334	0	9.9
MANGANESE, As Mn	LE	0.01	mg/L	7	58	0	0.02
pH	GE	8.8		336	336	0	7.2
	LE	9.4					
SUSPENDED SOLIDS	LE	0.05	mg/L	30	30	0	76
TOTAL DISSOLVED SOLIDS	LE	0.5	mg/L	211	211	0	115
ZINC, As Zn	LE	0.01	mg/L	64	67	0	0.05
TOTAL				2506	2609	0	

PROTECTION OF THE AQUATIC ENVIRONMENT

Freshwater Environment

An analysis of the stream water data (Table 19) indicated that more than 25 per cent of the samples exceeded the copper guideline and 20 per cent exceeded the iron guideline. Slightly higher than desirable zinc concentrations were observed on the Brudenell River and North Brook. Very few samples, primarily in the western portion of the province, were in noncompliance with the alkalinity and pH guidelines, and as indicated by the medians of the noncompliant values these contraventions were insignificant.

Marine Environment

The estuary and ocean water data can be assessed with respect to the guidelines for the protection of the marine environment. Three guideline levels which may be applicable are:

- (1) guidelines for concentrations which pose a hazard to the marine aquatic environment (Table 40, Appendix I);

- (2) the more stringent guidelines which pose a minimal risk of adverse effects to marine aquatic life (Table 41, Appendix I); and
- (3) guidelines for potentially hazardous nutrient concentrations which may cause oxygen depletion by enhancing aquatic respiration (Table 42, Appendix I).

Protection of Marine Aquatic Life

An analysis of the estuary water data for Prince Edward Island revealed that all the prescribed pesticide guideline levels (Table 20) were below the detection limit of the chemical methods used. The one positive value $0.01 \mu\text{g/L}$ for p,p'-DDT (Summerside Estuary) was in noncompliance with the guideline. More than 10 per cent of the copper values from all areas and approximately 8 per cent of the water samples analyzed for iron in the Summerside, Souris, and Cardigan Bay Estuaries exceeded the guideline slightly. Less than 2 per cent of the lead, manganese, zinc, cadmium, and pH values, usually single observations only, failed to comply with their guidelines.

Five per cent of the ocean water data exceeded the guidelines for the protection of marine aquatic life (Table 21), primarily as single values for copper and zinc.

TABLE 19

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *STREAM WATER* DATA IN RELATION TO
GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALKALINITY, As CaCO ₃	GT	20	mg/L	9	269	0	12
COPPER, As Cu	LE	0.005	mg/L	12	44	0	0.009
IRON, As Fe	LE	0.3	mg/L	17	93	0	0.4
LEAD, As Pb	LE	0.03	mg/L	0	45	0	
pH	GE	6.5		6	270	0	6.4
	LE	9.0					
ZINC, As Zn	LE	0.03	mg/L	5	43	0	0.04
TOTAL				49	764	0	

TABLE 20

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *ESTUARY WATER* DATA IN RELATION TO
GUIDELINES FOR THE PROTECTION OF MARINE AQUATIC LIFE

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALDRIN	LE	0.003	µg/L	0	0	124	
γ-BHC (LINDANE)	LE	0.004	µg/L	0	0	124	
CADMIUM, As Cd	LE	0.005	mg/L	5	1027	0	0.008
α-CHLORDANE	LE	0.004	µg/L	0	0	123	
COPPER, As Cu	LT	0.05	mg/L	108	1001	0	0.07
p,p'-DDT	LE	0.001	µg/L	1	1	123	0.010
DIELDRIN	LE	0.003	µg/L	0	0	124	
α-ENDOSULFAN	LE	0.001	µg/L	0	0	123	
ENDRIN	LE	0.004	µg/L	0	0	124	
HEPTACHLOR	LE	0.001	µg/L	0	0	124	
IRON, As Fe	LT	0.3	mg/L	15	197	0	0.5
LEAD, As Pb	LT	0.05	mg/L	19	1023	0	0.06
MANGANESE, As Mn	LE	0.10	mg/L	10	596	0	0.15
p,p'-METHOXYCHLOR	LE	0.03	µg/L	0	0	124	
pH	GE	6.5		10	1016	0	5.2 [5]
	LE	8.5					8.7 [5]
ZINC, As Zn	LT	0.1	mg/L	10	977	0	0.2
TOTAL				178	5838	1113	

[] - Number of values

TABLE 21

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF OCEAN WATER DATA IN RELATION TO
GUIDELINES FOR THE PROTECTION OF MARINE AQUATIC LIFE

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
CADMIUM, As Cd	LE	0.005	mg/L	0	23	0	0.07
COPPER, As Cu	LT	0.05	mg/L	4	23	0	
LEAD, As Pb	LT	0.05	mg/L	0	23	0	
MANGANESE, As Mn	LE	0.10	mg/L	0	10	0	
pH	GE	6.5		0	23	0	
	LE	8.5					
ZINC, As Zn	LT	0.1	mg/L	2	18	0	0.19
TOTAL				6	120	0	

Only six parameters were assessed due to the limited number of parameters chemically analyzed.

Minimal Risk of Adverse Effects to Marine Aquatic Life

Thirty-three per cent of the values for the three heavy metals (copper, lead, and zinc) on the estuary data (Table 22), exceed the guidelines specified at virtually all stations. Forty-two per cent of the ocean water data (Table 23) exceeded the three heavy metal guidelines, especially copper.

Potentially Hazardous Nutrient Concentrations

Nitrogen and phosphorus concentrations in excess of 0.36 and 0.05 mg/L, respectively (Table 42, Appendix I) may potentially exhaust the available oxygen in estuarine water due to increased respiration thus posing a potential threat to the aquatic ecosystem. Slightly more than 8 per cent of samples analyzed (Table 24) were in excess of these guidelines. The nutrient sources may have originated from either municipal sewage and/or agricultural wastes and runoff.

TABLE 22

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF ESTUARY WATER DATA IN RELATION TO
GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
COPPER, As Cu	LT	0.005	mg/L	445	1001	0	0.27
LEAD, As Pb	LT	0.01	mg/L	183	1023	0	0.02
ZINC, As Zn	LT	0.02	mg/L	362	977	0	0.04
TOTAL				990	3001	0	

TABLE 23

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF OCEAN WATER DATA IN RELATION TO
GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
COPPER, As Cu	LT	0.005	mg/L	13	23	0	0.045
LEAD, As Pb	LT	0.01	mg/L	5	23	0	0.012
ZINC, As Zn	LT	0.02	mg/L	9	18	0	0.046
TOTAL				27	64	0	

TABLE 24

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF ESTUARY WATER DATA IN RELATION TO
GUIDELINES FOR POTENTIALLY HAZARDOUS NUTRIENT CONCENTRATIONS

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
NITROGEN, DISSOLVED, As N	LE	0.36	mg/L	52	1001	0	0.68
PHOSPHORUS, TOTAL, As P	LE	0.05	mg/L	90	729	0	0.07
TOTAL				142	1730	0	

Excessive phosphorus levels occurred throughout the estuaries with dense populations on their shores, namely the Summerside and Charlottetown Harbour-Hillsborough Estuaries. Nitrogen and phosphorus non-compliances were also evident throughout the Kildare River Estuary (17 per cent noncompliances) with infrequent nitrogen noncompliances in the other estuaries. The most frequent noncompliances for both nutrients occurred at two sites in the Summerside Estuary. One site (02PE01CB0006) was influenced directly by inputs from the Wilmot River, which drains an area with significant agricultural activity. Station 02PE01CB0005 (orange, Figure 1, Appendix IV), which is about 1 kilometre south of the town of Summerside exhibited noncompliances for both nutrients on 30 per cent of the samples analyzed and may be related to municipal sewage inputs to the

estuary. Another site of frequent noncompliances occurred in the Yorke River Estuary near Charlottetown. In the '01CE' drainage area, sampling sites influenced by anthropogenic sources on the Brudenell and Montague Rivers also recorded several samples which failed to comply with the guideline levels.

Pesticides

Maximum Permissible Levels

Tables 25 and 26 indicate that of the nine pesticides analyzed with maximum permissible levels prescribed, all of the values were below the guidelines for the 1350 estuary samples and 575 stream water samples.

TABLE 25

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *STREAM WATER* DATA IN RELATION TO
MAXIMUM PERMISSIBLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALDRIN	LE	17.0	µg/L	0	64	0	
γ-BHC (LINDANE)	LE	56.0	µg/L	0	64	0	
CHLORDANE	LE	3.0	µg/L	0	64	0	
p,p'- DDT	LE	42.0	µg/L	0	64	0	
DIELDRIN	LE	17.0	µg/L	0	63	0	
ENDRIN	LE	1.0	µg/L	0	64	0	
HEPTACHLOR	LE	18.0	µg/L	0	64	0	
HEPTACHLOR EPOXIDE	LE	18.0	µg/L	0	64	0	
p,p'- METHOXYCHLOR	LE	35.0	µg/L	0	64	0	
TOTAL				0	575	0	

TABLE 26

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF *ESTUARY WATER* DATA IN RELATION TO
MAXIMUM PERMISSIBLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALDRIN	LE	17.0	µg/L	0	151	0	
γ-BHC (LINDANE)	LE	56.0	µg/L	0	151	0	
CHLORDANE	LE	3.0	µg/L	0	150	0	
p,p'- DDT	LE	42.0	µg/L	0	151	0	
DIELDRIN	LE	17.0	µg/L	0	151	0	
ENDRIN	LE	1.0	µg/L	0	151	0	
HEPTACHLOR	LE	18.0	µg/L	0	151	0	
HEPTACHLOR EPOXIDE	LE	18.0	µg/L	0	151	0	
p,p'- METHOXYCHLOR	LE	35.0	µg/L	0	151	0	
TOTAL				0	1358	0	

Objective and Acceptable Levels

Single value noncompliances occurred on stream water samples from Green Brook, Hunter River, Hyde (Mill) Creek and Mills (Bells) Creek for α -BHC, p-p' DDT, endrin and heptachlor, respectively (Table 27). Seventy estuary samples mainly from the Summerside, Charlottetown Harbour-Hillsborough and Cardigan Bay areas exceeded the (not detectable) guideline for α -BHC (Table 28). A single noncompliance for heptachlor occurred in the Covehead Bay Estuary and two values from the Summerside Estuary exceeded the guideline for p-p' DDT. Overall less than 5 per cent of the samples analyzed for 11 pesticides failed to comply with the suggested guidelines.

SEAWATER COMPARISONS

Finally, a comparison of the estuary and ocean water data with "standard seawater" concentrations (Table 45, Appendix I) emphasized the brackish nature of the estuary water. All the major ion concentrations are less than "standard seawater" and therefore in noncompliance with the levels stated in Table 29. But of more importance, this assessment of the data (Tables 29 and 30) indicates that the heavy metals were very frequently

in excess of "standard seawater" concentrations. More than 90 per cent of the water samples analyzed for lead in both the estuarine and marine areas (orange and red, Figure 1, Appendix IV) had concentrations in excess of "standard seawater". Copper, zinc, and cadmium concentrations were greater than "standard seawater" in at least 40 per cent of the water samples analyzed, and virtually all the iron and manganese results exceeded the "standard seawater" concentrations.

It is reasonable to postulate that the origin of these heavy metals (copper, zinc, lead, and cadmium) was anthropogenic, since no known geochemical sources which could elevate the levels of these metals exist on Prince Edward Island. By considering the oceanic sampling sites as composites of the estuaries an assessment of anthropogenic inputs may be made. The Rustico and Murray Harbour regions are more densely populated and industrialized than the Alberton Harbour region. The two sampling sites in the former areas exhibited values in excess of "standard seawater" on more than 70 per cent of the samples (Table 94, Appendix I), whereas at the Alberton Harbour sampling site less than 50 per cent of the samples analyzed had excessive levels of heavy metals. These observations lend credence to the postulate that the elevated heavy metal concentrations could be attributed to anthropogenic sources.

TABLE 27
SUMMARY RESULTS
COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
OBJECTIVE AND ACCEPTABLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL	NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
		NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALDRIN	ND $\mu\text{g/L}$	0	64	0	
α -BHC	ND $\mu\text{g/L}$	1	64	0	0.008 (0.001)
γ -BHC (LINDANE)	ND $\mu\text{g/L}$	0	64	0	
α -CHLORDANE	ND $\mu\text{g/L}$	0	64	0	
γ -CHLORDANE	ND $\mu\text{g/L}$	0	64	0	
p,p' - DDT	ND $\mu\text{g/L}$	1	64	0	0.052 (0.001)
DIELDRIN	ND $\mu\text{g/L}$	0	63	0	
ENDRIN	ND $\mu\text{g/L}$	1	64	0	0.006 (0.001)
HEPTACHLOR	ND $\mu\text{g/L}$	1	64	0	0.006 (0.001)
HEPTACHLOR EPOXIDE	ND $\mu\text{g/L}$	0	64	0	
p,p' - METHOXYCHLOR	ND $\mu\text{g/L}$	0	64	0	
TOTAL		4	703	0	

() - Level of Detection Limit

TABLE 28

SUMMARY RESULTS
COMPLIANCE ANALYSIS OF ESTUARY WATER DATA IN RELATION TO
OBJECTIVE AND ACCEPTABLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL		NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
			NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
ALDRIN	ND	µg/L	0	151	0	
α-BHC	ND	µg/L	70	149	0	0.005 (0.001)
γ-BHC (LINDANE)	ND	µg/L	0	151	0	
α- CHLORDANE	ND	µg/L	0	150	0	
γ- CHLORDANE	ND	µg/L	0	148	0	
p,p'- DDT	ND	µg/L	2	151	0	0.010 (0.001)
DIELDRIN	ND	µg/L	0	151	0	
ENDRIN	ND	µg/L	0	151	0	
HEPTACHLOR	ND	µg/L	1	151	0	0.008 (0.001)
HEPTACHLOR EPOXIDE	ND	µg/L	0	151	0	
p,p'- METHOXYCHLOR	ND	µg/L	0	151	0	
TOTAL			73	1655	0	

() - Level of Detection Limit

TABLE 29

SUMMARY RESULTS
COMPARISON OF ESTUARY WATER DATA TO
'STANDARD SEAWATER' CONCENTRATIONS

PARAMETER	LEVEL		NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
			NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
CADMIUM, As Cd	ND	mg/L	401	1027	0	0.001 (0.001)
CALCIUM, As Ca	GE 400.	mg/L	177	197	0	310
CHLORIDE, As Cl-	GT 19 000.	mg/L	197	197	0	6750
COPPER, As Cu	LE 0.003	mg/L	473	1001	0	0.025
IRON, As Fe	LE 0.01	mg/L	196	197	0	0.09
LEAD, As Pb	ND	mg/L	932	1023	0	0.005 (0.001)
MAGNESIUM, As Mg	GE 1350	mg/L	1025	1026	0	999
MANGANESE, As Mn	LE 0.002	mg/L	360	362	234	0.019
PHOSPHORUS, TOT.INORG., As P	LE 0.7	mg/L	1	1022	0	1.0
POTASSIUM, As K	GE 380.	mg/L	97	196	0	303
SODIUM, As Na	GT 10 500.	mg/L	196	196	0	8277
SULPHATE, As SO ₄ ²⁻	GE 885.	mg/L	26	458	0	288
ZINC, As Zn	LE 0.01	mg/L	516	977	0	0.03
TOTAL			4597	7879	234	

() - Level of Detection Limit

TABLE 30

SUMMARY RESULTS
COMPARISON OF OCEAN WATER DATA TO
'STANDARD SEAWATER' CONCENTRATIONS

PARAMETER	LEVEL			NUMBER OF			MEDIAN OF NON- COMPLIANT VALUES
				NON- COMPLIANT VALUES	INCLUDED VALUES	EXCLUDED VALUES	
CADMIUM, As Cd		ND	mg/L	11	23	0	0.001 (0.001)
COPPER, As Cu	LE	0.003	mg/L	14	23	0	0.034
LEAD, As Pb		ND	mg/L	22	23	0	0.006 (0.001)
MAGNESIUM, As Mg	GE	1350	mg/L	22	22	0	1035
MANGANESE, As Mn	LE	0.002	mg/L	3	3	7	0.006
PHOSPHORUS, TOT.INORG., As P	LE	0.7	mg/L	0	23	0	
ZINC, As Zn	LE	0.01	mg/L	9	18	0	0.005
TOTAL				81	135	7	

() - Level of Detection Limit

Summary

The surface waters of Prince Edward Island were typically calcium or calcium-magnesium bicarbonate waters of moderately low alkalinities and total dissolved solids. The groundwater sites sampled were predominantly calcium-magnesium bicarbonate waters, especially in the eastern portion of the province. The central and western sites tended to be more calcareous. A few wells close to the coast showed slightly elevated sodium chloride levels. The groundwaters are richer in total dissolved solids than the surface waters and exhibited low to moderate hardness.

The order of dominance for the major ions in both Prince Edward Island surface and groundwaters was: $\text{HCO}_3^- > \text{Ca} > \text{Mg} > \text{Cl} > \text{Na} > \text{SO}_4 > \text{K}$. There were well-defined empirical relationships between specific conductance and the major ions for the surface waters and some of the groundwaters. The conservative constituents (i.e. major ions) in the stream waters sampled were predictable from discharge measurements, whereas parameters such as the pesticides, heavy metals, and the nutrients were both spatially and temporally variable. The estimated nutrient loadings of the Mill and Brudenell Rivers to their estuaries were quite variable. Since the nutrients in these streams are controlled by agricultural practices such as crop fertilization and waste disposal, which subsequently stimulates aquatic plant growth, a monthly sampling program is considered inadequate to assess the true magnitude and variability of the nutrient loads.

At the Mill River site, monthly water quality samples were taken for 8 years (1966 to 1973, inclusive). During this sampling period the full spectrum of discharge conditions at the sampling station was experienced, thus discharge-related water quality data should not have been biased by stream discharge at this site. The Mill River exhibited an excellent inverse relationship between pH and discharge. The relationship at the other stream sites was either less well-defined or non-existent. A pH versus time plot of the Mill River data indicated an apparent decrease in pH over the 8-year period of record. The pH change was attributable to neither land use practices nor municipal and/or industrial development.

The edaphic conditions of acid soils with excessive runoff allowed the direct effects of atmospheric inputs to be seen in the surface waters. Thus, there was a direct relationship between periods of high discharge and downward inflections in the stream pH.

Although most Prince Edward Island waters are suitable for domestic consumption, the waters assessed would have required at least minimal treatment in order to comply with the *objective* guidelines for drinking waters. Of the 18 parameters assessed on the data base the parameters of particular concern were the heavy metals, especially lead, ammonia, and to a lesser degree turbidity, colour, and hardness. The stream water samples were more highly coloured than the groundwater samples and excessive turbidities frequently occurred in both types of samples. The high ammonia levels observed at the four stream sites and in nine wells may have been of agricultural origin or possibly related to site-specific waste disposal. The excess nitrate observed in the Mount Carmel well may have also been due to similar causes. The elevated heavy metal concentrations observed in the well water samples probably resulted from the action of corrosive groundwaters on metallic storage tanks and distribution systems and were not due to high heavy metal concentrations in the aquifers.

Both stream and groundwater sites were suitable for direct livestock watering in relation to the eight parameters assessed. Although there were a few noncompliances, primarily metals, on groundwater samples for some of the nine parameters assessed, the direct use of both stream and groundwater for irrigation should have posed no serious problems.

Of the 12 parameters assessed in relation to use in the food processing industry, only turbidity, suspended solids, and iron might have required removal prior to use. Minor noncompliances for nitrate occurred in the Mount Carmel well and also in the Lower Montague and Cardigan wells. Twelve parameters were assessed in relation to high-pressure steam generation for electrical utilities. As can be expected with the very high quality feedwater required for this application, all Prince Edward

Island surface and groundwaters would have needed treatment prior to use.

The four stream sites were assessed for seven parameters which are of concern for the protection of freshwater aquatic life. Only copper and iron failed to comply with the guidelines. Sixteen parameters for the protection of marine aquatic life were assessed and the guidelines were exceeded a number of times for copper and iron, with only slight noncompliances for lead, manganese, zinc, cadmium, and pH. Fully one third of the water samples for the three heavy metals (copper, lead, zinc) at the estuary sites and over 40 per cent of the ocean water samples exceeded the guidelines related to minimal risk to marine aquatic life. Excessive nutrients occurred in the Summerside and Charlottetown Estuaries and to a lesser extent in the Kildare Estuary probably as a result of municipal waste disposal and/or agricultural runoff.

An assessment of 11 pesticides at 71 freshwater and 99 estuary sites showed single positive values at only four freshwater locations and 70 positive values for α -BHC in the Summerside, Charlottetown, and Cardigan Bay Estuaries, which represents less than five per cent of the data.

Very frequently heavy metal concentrations were found in excess of the "standard seawater" levels, especially for lead (>90% of the samples). More than 40 per cent of the copper, zinc, and cadmium samples and virtually all the iron and manganese samples exhibited concentrations greater than "standard seawater". Although the iron and manganese concentrations may have been derived from natural sources, there are no known geochemical sources on Prince Edward Island for the other heavy metals and, therefore, they were presumed to be of anthropogenic origin.

Acknowledgments

The authors wish to acknowledge the expertise, insight, and perseverance of Dr. J.F. Dlouhy who developed the "Noncompliance Program" while on contract with the Water Quality Branch. Our thanks to Mr. C. Murphy, Department of the Environment, Prince Edward Island, who was originally involved in the field work on the estuary and special studies, and who has provided us with background information on many of the sampling sites discussed in the text.

Our thanks to Ms E. Hunt, who provided unending

help with all facets of the NAQUADAT system and in particular with the computerized plots which appear in the text. The authors also acknowledge the helpful suggestions provided by the regional offices of the Water Quality Branch. The foldout maps were produced by the Drafting Section, IWD, for an earlier publication.

We would like to extend our appreciation to Ms M.E. Lajeunesse, who patiently struggled to type an almost illegible manuscript.

Glossary

Aesthetic:	conditions perceptible by the senses.
Alkali Metals:	metals in group IA of the Periodic Table which typically form oxides (lithium, sodium, potassium, rubidium, and cesium).
Alkaline Earth Metals:	metals in group IIA of the Periodic Table which typically form oxides and carbonates (beryllium, magnesium, calcium, strontium, barium, and radium).
Anthropogenic:	relating to or involving the impact of man.
Aquifer:	a geological formation (bedrock or overburden) or porous soil through which water may percolate yielding groundwater to springs and wells.
Bedrock:	solid rock exposed on the surface by erosion or found underlying unconsolidated weathered rock and soil materials.
Biota:	living organisms including bacteria, plants, and animals.
Brackish:	water with less salt than seawater but undrinkable. Waters having salinity values between 0.5 and 17 parts per thousand.
Breccia:	rock composed of coarse angular fragments, cemented together.
Buffering Capacity:	the ability of a system to resist a change in pH.
Calcareous:	material containing calcium carbonate in sufficient concentrations to effervesce with cold dilute hydrochloric acid (0.1 normal).
Catena:	a connected series of related things.
Coliform Bacteria:	non-pathogenic bacteria found in all soil and plant material, but the presence of <i>Escherichia coli</i> , a coliform bacterium, usually indicates contamination by human wastes.
Decile Levels:	values on a cumulative frequency distribution (diagram) at progressive one tenth (1/10) intervals. The 1st decile equals one tenth (1/10) of the total number of values.
Dolomitic:	materials containing calcium-magnesium carbonate.
Edaphic:	relates to the influence of soil and its properties on the ecosystem.
Exogenous:	due to an external cause or not arising within the basin or system.
"Flashy" Hydrograph:	a graphical representation of the discharge of water at a given location as a function of time which exhibits a very spiked trace.
Geochemical:	relates to the chemical elements associated with minerals, rocks, and soils, and their effects on the hydrosphere and the atmosphere.

Groundwater:	water occurring below the water table in porous rock and overburden.
Heavy Metals:	metallic elements of high atomic weights (eg. copper, lead, etc.) typically with specific gravities greater than five.
Median:	a value in an ordered set of values below and above which there is an equal number of values. The fifth decile.
Meteoric:	water which originates in the atmosphere and reaches the earth by precipitation.
Milliequivalent:	one one-thousandth ($\text{milli} = 10^{-3} = 1/1000$) of an equivalent weight which is the molecular weight of an element or compound, divided by the valence change in a chemical reaction.
Non-conservative:	a chemical constituent which undergoes active biological transformations.
Orthic Podzols:	soils with an eluviated, light-coloured (Ae) horizon below a well-developed organic surface horizon. They typically indicate good drainage under acid conditions.
Temporal:	pertaining to or limited by time.

Symbols and Abbreviations

Throughout this text the International System (SI) notation for units has been used except for one parameter, discharge, which is given in cubic feet per second (cfs).

SI PREFIXES

Multiplying Factor	Prefix	Symbol
1 000 000 = 10^6	mega	M
1 000 = 10^3	kilo	k
100 = 10^2	hecto	h
10 = 10^1	deca	da
1 = 10^0		
0.1 = 10^{-1}	deci	d
0.01 = 10^{-2}	centi	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ

QUALIFIERS

LT	- less than
LE	- less than or equal to
GT	- greater than
GE	- greater than or equal to

UNITS

cfs	cubic feet per second
kg/a	kilograms per annum
kg/L	kilograms per litre
meq/L	milliequivalents per litre
mg/L	milligrams per litre
μ g/L	micrograms per litre
USIE/cm or μ S/cm	microsiemens per centimetre

ABBREVIATIONS

JTU	- Jackson Turbidity Units
ND	- Not Detectable
TCU	- True Colour Units
TDS	- Total Dissolved Solids
TON	- Threshold Odour Number
WQB	- Water Quality Branch
WSC	- Water Survey of Canada
ΣCO_2	- Total Carbon Dioxide

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Guideline Tables (Complete) and Detailed Noncompliance Tables

Appendix I

Guideline Tables (Complete) and Detailed Noncompliance Tables

Guideline Tables (Complete) and Detailed Noncompliance Tables

This appendix is composed of two sections. Section 1 contains complete guideline tables 31 to 45 for all the applications considered in this report. These tables detail (i) all the parameters of concern for a specific application, (ii) the guideline level proposed, and (iii) the reference source. Upon consulting various reference sources, when a number of levels were encountered the most stringent level was selected, and when a number of sources prescribed the same level, then the Canadian source was used.

All the guideline levels are prefixed by the symbols LT, LE, GT, and GE, where LT means less than; LE means less than or equal to; GT means greater than; GE means greater than or equal to.

Other symbols appearing in the "levels" column of the tables are ND - not detectable; mg/L - milligrams per litre; $\mu\text{g/L}$ - micrograms per litre; JTU - Jackson Turbidity Units; TCU - True Colour Units; TON - Threshold Odour Number.

Section 2 (Tables 46 to 94) comprises (a) a guideline table for the parameters available on the data set(s) being analyzed and (b) if there were noncompliances, a table listing the number of noncompliances per number of values statistically analyzed by the program for each individual station on the data set for each parameter. Note: This table is not included if all values on the data set were in compliance with the guidelines specified. The symbol (-) in the latter table indicates either (i) there were *no noncompliances* at that particular station for the parameter being considered; or (ii) there were *no data* for the parameter in question at that station.

The program used in this type of assessment emphasizes the noncompliances on the data set. In certain cases very few of the parameters noted in Section 1 can be assessed because no data are available, since the sampling program(s) may not have been designed to assess that particular water use.

Section 1: Guideline Tables

TABLE 31

MAXIMUM PERMISSIBLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER		LEVEL	REFERENCE
ARSENIC, As As	LE	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
BARIUM, As Ba	LE	1.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CADMIUM, As Cd	LE	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHROMIUM, As Cr(VI)	LE	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CYANIDE, As CN ⁻	LE	0.20 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, As F ⁻	LE	1.5 mg/L	ENVIRONMENT CANADA, IWD, TECH. BULL. 67, 1972
LEAD, As Pb	LE	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LE	10.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SELENIUM, As Se	LE	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SILVER, As Ag	LE	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 32

ACCEPTABLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER		LEVEL	REFERENCE
ALKALINITY, As CaCO ₃	GE	30 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
ALKALINITY, As CaCO ₃	LE	500 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
AMMONIA, As N	LE	0.5 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
ARSENIC, As As	LE	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
BARIUM, As Ba	LT	1.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
BORON, As B	LT	5.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CADMIUM, As Cd	LT	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CALCIUM, As Ca	LE	200 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, As Cl ⁻	LE	250 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHROMIUM, As Cr(VI)	LT	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
COLOUR	LE	15 TCU	NATIONAL HEALTH & WELFARE, CANADA, 1969
COPPER, As Cu	LE	1.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CYANIDE, As CN ⁻	LE	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, As F ⁻	LE	1.4 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
HARDNESS, TOTAL, As CaCO ₃	LT	500.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, DISSOLVED, As Fe	LE	0.3 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, As Pb	LT	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MAGNESIUM, As Mg	LE	150 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MANGANESE, As Mn	LE	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LT	10.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
pH	GE	6.5	NATIONAL HEALTH & WELFARE, CANADA, 1969
pH	LE	8.3	NATIONAL HEALTH & WELFARE, CANADA, 1969
PHENOLIC SUBSTANCES, As PHENOL	LE	0.002 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHORUS, TOT.INORG., As P	LE	0.2 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SELENIUM, As Se	LT	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHATE, As SO ₄ ²⁻	LE	500 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHIDE, As H ₂ S	LE	0.3 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TOTAL DISSOLVED SOLIDS	LE	1000 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TURBIDITY	LE	5 JTU	NATIONAL HEALTH & WELFARE, CANADA, 1969
URANYL ION, As UO ₂ ²⁺	LE	5.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
ZINC, As Zn	LE	5.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 33

OBJECTIVE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER		LEVEL	REFERENCE
AMMONIA, As N	LE	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
ARSENIC, As As		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
BARIUM, As Ba		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CADMIUM, As Cd		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CALCIUM, As Ca	LT	75 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, As Cl ⁻	LT	250 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHROMIUM, As Cr(VI)		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
COLOUR	LE	5 TCU	NATIONAL HEALTH & WELFARE, CANADA, 1969
COPPER, As Cu	LT	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CYANIDE, As CN ⁻		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, As F ⁻	LT	1.2 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
HARDNESS, TOTAL, As CaCO ₃	LT	120 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, DISSOLVED, As Fe	LT	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, As Pb		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MAGNESIUM, As Mg	LT	50 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MANGANESE, As Mn	LT	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LT	10.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
PHENOLIC SUBSTANCES, As PHENOL		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHORUS, TOT.INORG., As P	LT	0.2 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SELENIUM, As Se		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHATE, As SO ₄ ²⁻	LT	250 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHIDE, As H ₂ S		ND mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TOTAL DISSOLVED SOLIDS	LT	500 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TURBIDITY	LE	1 JTU	NATIONAL HEALTH & WELFARE, CANADA, 1969
URANYL ION, As UO ₂ ²⁻	LT	1.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
ZINC, As Zn	LT	1.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 34

THE SATURATION INDEX

PARAMETER		LEVEL	REFERENCE
SATURATION INDEX	GE	-0.75	MINES & TECH. SURV. CANADA, WAT. SURV. RPT. 1

TABLE 35

GUIDELINES FOR LIVESTOCK WATERING

PARAMETER		LEVEL	REFERENCE
ALUMINUM, As Al	LE	5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ARSENIC, As As	LE	0.2 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BORON, As B	LE	5.0 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CADMIUM, As Cd	LE	0.050 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CALCIUM, As Ca	LE	1000 mg/L	AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
CHROMIUM, As Cr	LE	1.0 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COBALT, As Co	LE	1.0 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COPPER, As Cu	LE	0.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
FLUORIDE, As F ⁻	LE	2.0 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LE	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MERCURY, As Hg	LE	10 µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MOLYBDENUM, As Mo	LE	0.01 mg/L	AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
NITRATE + NITRITE, As N	LE	100 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SELENIUM, As Se	LE	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SULPHATE, As SO ₄ ²⁻	LE	1000 mg/L	AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
VANADIUM, As V	LE	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LE	25 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 36

GUIDELINES FOR IRRIGATION OF ACIDIC SOILS

PARAMETER	LEVEL			REFERENCE
ALUMINUM, As Al	LE	5.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ARSENIC, As As	LE	0.10	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BERYLLIUM, As Be	LE	0.10	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BORON, As B	LE	0.75	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CADMIUM, As Cd	LE	0.010	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CHROMIUM, As Cr	LE	0.1	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COBALT, As Co	LE	0.050	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COPPER, As Cu	LE	0.20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
FLUORIDE, As F ⁻	LE	1.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
IRON, As Fe	LE	5.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LE	5.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LITHIUM, As Li	LE	2.5	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MANGANESE, As Mn	LE	0.20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MOLYBDENUM, As Mo	LE	0.010	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
NICKEL, As Ni	LE	0.2	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	GE	4.5		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	LE	9.0		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SELENIUM, As Se	LE	0.02	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SODIUM ABSORPTION RATIO	LT	8		AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
VANADIUM, As V	LE	0.10	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LE	2.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 37

GUIDELINES FOR FOOD PROCESSING INDUSTRIES

PARAMETER	LEVEL			REFERENCE
ALKALINITY, As CaCO ₃	LE	150	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
CHLORIDE, As Cl ⁻	LE	250	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
FLUORIDE, As F ⁻	LE	1	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
HARDNESS, As CaCO ₃	LE	150	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
IRON, As Fe	LE	0.2	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
MANGANESE, As Mn	LE	0.2	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
NITRATE, As N	LE	10	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
NITRITE, As N		ND	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
ODOUR		ND	TON	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
pH	GE	6.5		ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
pH	LE	8.5		ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
PHENOLIC MATERIAL, As PHENOL		ND	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SILICA, As SiO ₂	LE	50	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SULPHATE, As SO ₄ ²⁻	LE	250	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SUSPENDED SOLIDS	LE	10	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
TOTAL DISSOLVED SOLIDS	LE	500	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
TURBIDITY		ND	JTU	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974

TABLE 38

GUIDELINES FOR ELECTRICAL UTILITIES (HIGH PRESSURE STEAM GENERATION)

PARAMETER	LEVEL	REFERENCE
ALKALINITY, As CaCO_3	LE 1 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ALUMINUM, As Al	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BICARBONATE, As HCO_3	LE 0.5 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CALCIUM, As Ca	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COPPER, As Cu	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
HARDNESS, TOTAL, As CaCO_3	LE 0.07 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
IRON, As Fe	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MAGNESIUM, As Mg	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MANGANESE, As Mn	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
OXYGEN, DISSOLVED, As O_2	LE 0.007 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	GE 8.8	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	LE 9.4	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SILICA, As SiO_2	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SUSPENDED SOLIDS	LE 0.05 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
TOTAL DISSOLVED SOLIDS	LE 0.5 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LE 0.01 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 39

GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

PARAMETER	LEVEL	REFERENCE
ALDRIN	LE 0.001 $\mu\text{g/L}$	INTERNATIONAL JOINT COMMISSION, 1976
ALKALINITY, As CaCO_3	GT 20 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
BERYLLIUM, As Be	LE 0.011 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
γ -BHC (LINDANE)	LE 0.01 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
CADMIUM, As Cd	LE 0.003 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
CHLORDANE	LE 0.01 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
CHROMIUM, As Cr(VI)	LE 0.05 mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
COPPER, As Cu	LE 0.005 mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
CYANIDE, As CN^-	LE 0.005 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
p,p'- DDT	LE 0.003 $\mu\text{g/L}$	INTERNATIONAL JOINT COMMISSION, 1976
DIAZINON	LE 0.08 $\mu\text{g/L}$	GREAT LAKES WATER QUALITY BOARD, 1976
DIELDRIN	LE 0.001 $\mu\text{g/L}$	INTERNATIONAL JOINT COMMISSION, 1976
α -ENDOSULFAN	LE 0.003 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
β -ENDOSULFAN	LE 0.003 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ENDRIN	LE 0.002 $\mu\text{g/L}$	INTERNATIONAL JOINT COMMISSION, 1976
GUTHION	LE 0.005 $\mu\text{g/L}$	GREAT LAKES WATER QUALITY BOARD, 1976
HEPTACHLOR	LE 0.001 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
IRON, As Fe	LE 0.3 mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
LEAD, As Pb	LE 0.03 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MALATHION	LE 0.1 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
MERCURY, As Hg	LE 0.2 $\mu\text{g/L}$	GREAT LAKES WATER QUALITY BOARD, 1976
p,p'- METHOXYCHLOR	LE 0.03 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
MIREX	LE 0.001 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
NICKEL, As Ni	LE 0.025 mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
OXYGEN, DISSOLVED, As O_2	GE 5.0 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
PARATHION	LE 0.008 $\mu\text{g/L}$	GREAT LAKES WATER QUALITY BOARD, 1976
pH	GE 6.5	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	LE 9.0	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
PHENOLIC SUBSTANCES, As PHENOL	LE 0.001 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
POLYCHLORINATED BIPHENYLS	LE 0.001 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
SULPHIDE, As H_2S	LE 0.002 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
TOXAPHENE	LE 0.005 $\mu\text{g/L}$	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ZINC, As Zn	LE 0.03 mg/L	GREAT LAKES WATER QUALITY BOARD, 1976

TABLE 40

GUIDELINES FOR THE PROTECTION OF MARINE AQUATIC LIFE

PARAMETER		LEVEL	REFERENCE
ALDRIN	LE	0.003 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ALUMINUM, As Al	LE	1.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ANTIMONY, As Sb	LT	0.2 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ARSENIC, As As	LT	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BARIUM, As Ba	LT	1.0 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BERYLLIUM, As Be	LT	1.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
γ -BHC (LINDANE)	LE	0.004 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
BORON, As B	LE	5.0 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CADMIUM, As Cd	LE	0.005 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
α -CHLORDANE	LE	0.004 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
CHROMIUM, As Cr(VI)	LE	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
COPPER, As Cu	LT	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CYANIDE, As CN^-	LE	0.005 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
p,p'-DDT	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
DIELDRIN	LE	0.003 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
α -ENDOSULFAN	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
β -ENDOSULFAN	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ENDRIN	LE	0.004 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
FLUORIDE, As F^-	LT	1.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
GUTHION	LE	0.01 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
HEPTACHLOR	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
IRON, As Fe	LT	0.3 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LT	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MALATHION	LE	0.1 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
MANGANESE, As Mn	LE	0.10 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
MERCURY, As Hg	LE	0.10 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
p,p'-METHOXYCHLOR	LE	0.03 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
MIREX	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
NICKEL, As Ni	LE	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
PARATHION	LE	0.04 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	GE	6.5	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	LE	8.5	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
POLYCHLORINATED BIPHENYLS	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
SELENIUM, As Se	LT	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SILVER, As Ag	LT	0.005 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SULPHIDE, As H_2S	LE	0.002 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
THALLIUM, As Tl	LT	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
TOXAPHENE	LE	0.005 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
URANIUM, As U	LT	0.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LT	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 41

GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

PARAMETER		LEVEL	REFERENCE
ALUMINUM, As Al	LT	0.2 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ARSENIC, As As	LT	0.01 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BARIUM, As Ba	LT	0.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BERYLLIUM, As Be	LT	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BORON, As B	LT	5.0 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COPPER, As Cu	LT	0.005 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
FLUORIDE, As F ⁻	LT	0.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
IRON, As Fe	LT	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LT	0.01 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
NICKEL, As Ni	LE	0.002 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SELENIUM, As Se	LT	0.005 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SILVER, As Ag	LT	0.001 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
THALLIUM, As Tl	LT	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
URANIUM, As U	LT	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LT	0.02 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 42

GUIDELINES FOR POTENTIALLY HAZARDOUS NUTRIENT CONCENTRATIONS

PARAMETER		LEVEL	REFERENCE
NITROGEN, DISSOLVED, As N	LE	0.36 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
PHOSPHORUS, TOTAL, As P	LE	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 43

MAXIMUM PERMISSIBLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER		LEVEL	REFERENCE
ALDRIN	LE	17.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ-BHC (LINDANE)	LE	56.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORDANE	LE	3.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p' - DDT	LE	42.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
DIELDRIN	LE	17.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
ENDRIN	LE	1.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR	LE	18.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR EPOXIDE	LE	18.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p' - METHOXYCHLOR	LE	35.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TOXAPHENE	LE	5.0 µg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 44

OBJECTIVE AND ACCEPTABLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL	REFERENCE
ALDRIN	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
α -BHC	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ -BHC (LINDANE)	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
α -CHLORDANE	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-DDT	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
DIELDRIN	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
ENDRIN	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR EPOXIDE	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-METHOXYCHLOR	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
TOXAPHENE	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 45

'STANDARD SEAWATER' CONCENTRATIONS

PARAMETER	LEVEL	REFERENCE
CADMIUM, As Cd	ND mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
CALCIUM, As Ca	GE 400 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
CHLORIDE, As Cl^-	GT 19 000 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
COPPER, As Cu	LE 0.003 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
IRON, As Fe	LE 0.01 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
LEAD, As Pb	ND mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
MAGNESIUM, As Mg	GE 1350 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
MANGANESE, As Mn	LE 0.002 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
PHOSPHORUS, TOT.INORG., As P	LE 0.7 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
POTASSIUM, As K	GE 380 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
SODIUM, As Na	GT 10 500 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
SULPHATE, As SO_4^{2-}	GE 885 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
ZINC, As Zn	LE 0.01 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY

Section 2: Detailed Noncompliance Tables

TABLE 46

MAXIMUM PERMISSIBLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL		REFERENCE
FLUORIDE, As F ⁻	LE	1.5 mg/L	ENVIRONMENT CANADA, IWD, TECH. BULL. 67, 1972
LEAD, As Pb	LE	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LE	10.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 47

MAXIMUM PERMISSIBLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL		REFERENCE
CADMIUM, As Cd	LE	0.01 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, As F ⁻	LE	1.5 mg/L	ENVIRONMENT CANADA, IWD, TECH. BULL. 67, 1972
LEAD, As Pb	LE	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LE	10.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 48

**COMPLIANCE ANALYSIS OF GROUNDWATER DATA
IN RELATION TO MAXIMUM PERMISSIBLE RAW
WATER QUALITY LEVELS FOR DRINKING WATER
SUPPLY**

PARAMETER	CADMIUM As Cd	LEAD As Pb	NITRATE + NITRITE As N
STATION	NC/INCL*		
10PE01CA0003	—	—	—
10PE01CA0004	—	2/7	—
10PE01CA0005	—	2/5	—
10PE01CB0010	—	—	—
10PE01CB0011	—	—	—
10PE01CB0012	—	—	—
10PE01CB0013	—	—	—
10PE01CB0014	—	—	3/8
10PE01CB0015	—	—	—
10PE01CB0016	—	3/6	—
10PE01CB0017	—	—	—
10PE01CC0012	—	1/3	—
10PE01CC0013	—	1/3	—
10PE01CC0014	—	—	—
10PE01CC0015	—	—	—
10PE01CC0016	—	—	—
10PE01CC0017	—	—	—
10PE01CC0018	—	—	—
10PE01CC0019	—	—	—
10PE01CC0020	—	—	—
10PE01CC0021	—	6/6	—
10PE01CC0022	—	2/7	—
10PE01CC0023	—	1/5	—
10PE01CC0024	—	2/7	—
10PE01CC0025	—	2/12	—
10PE01CD0001	1/9	6/8	—
10PE01CE0001	—	—	1/9
10PE01CE0002	—	—	1/8
10PE01CE0003	—	—	—
10PE01CE0004	—	3/3	—
10PE01CE0005	—	5/7	—
10PE01CE0006	—	—	—

*NONCOMPLIANT/INCLUDED VALUES

TABLE 49

ACCEPTABLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER		LEVEL	REFERENCE
ALKALINITY, As CaCO_3	GE	30 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
ALKALINITY, As CaCO_3	LE	500 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
AMMONIA, As N	LE	0.5 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CALCIUM, As Ca	LE	200 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, As Cl^-	LE	250 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
COLOUR	LE	15 TCU	NATIONAL HEALTH & WELFARE, CANADA, 1969
COPPER, As Cu	LE	1.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, As F^-	LE	1.4 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
HARDNESS, TOTAL, As CaCO_3	LT	500.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, DISSOLVED, As Fe	LE	0.3 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, As Pb	LT	0.05 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MAGNESIUM, As Mg	LE	150 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LT	10.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
pH	GE	6.5	NATIONAL HEALTH & WELFARE, CANADA, 1969
pH	LE	8.3	NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHORUS, TOT.INORG., As P	LE	0.2 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHATE, As SO_4^{2-}	LE	500 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TOTAL DISSOLVED SOLIDS	LE	1000 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TURBIDITY	LE	5 JTU	NATIONAL HEALTH & WELFARE, CANADA, 1969
ZINC, As Zn	LE	5.0 mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 50

COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
ACCEPTABLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	ALKALINITY TOTAL As CaCO_3	AMMONIA As N	COLOUR	pH	PHOSPHORUS TOT.INORG. As P	TURBIDITY
STATION	NONCOMPLIANT / INCLUDED VALUES					
00PE01CA0001	18/86	2/17	59/88	5/87	2/30	12/88
00PE01CB0001	5/70	—	13/70	—	—	19/71
00PE01CB0017	2/30	1/9	1/30	1/30	—	3/30
00PE01CE0001	1/83	1/15	26/85	2/83	—	18/85

ACCEPTABLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

TABLE 52[illegible]

TABLE 53

OBJECTIVE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	LEVEL			REFERENCE
AMMONIA, As N	LE	0.01	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CALCIUM, As Ca	LT	75	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, As Cl ⁻	LT	250	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
COLOUR	LE	5	TCU	NATIONAL HEALTH & WELFARE, CANADA, 1969
COPPER, As Cu	LT	0.01	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, As F ⁻	LT	1.2	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
HARDNESS, TOTAL, As CaCO ₃	LT	120	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, DISSOLVED, As Fe	LT	0.05	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, As Pb		ND	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MAGNESIUM, As Mg	LT	50	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LT	10.0	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHORUS, TOT.INORG., As P	LT	0.2	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHATE, As SO ₄ ²⁻	LT	250	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TOTAL DISSOLVED SOLIDS	LT	500	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TURBIDITY	LE	1	JTU	NATIONAL HEALTH & WELFARE, CANADA, 1969
ZINC, As Zn	LT	1.0	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 54

COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
OBJECTIVE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	AMMONIA As N	CALCIUM As Ca	COLOUR	COPPER As Cu	IRON DISSOLVED As Fe	LEAD As Pb	PHOSPHORUS TOT.INORG. As P	TURBIDITY
STATION	NONCOMPLIANT / INCLUDED VALUES							
00PE01CA0001	15/15	—	71/88	1/11	10/21	5/11	2/30	59/88
00PE01CB0001	10/10	1/68	33/70	2/9	6/17	10/10	—	59/71
00PE01CB0017	3/3	—	4/30	1/12	1/7	8/12	—	17/30
00PE01CE0001	7/7	—	53/85	2/12	4/19	8/12	—	62/85

TABLE 55

OBJECTIVE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER		LEVEL		REFERENCE
AMMONIA, As N	LE	0.01	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CADMIUM, As Cd		ND	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CALCIUM, As Ca	LT	75	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, As Cl ⁻	LT	250	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
COLOUR	LE	5	TCU	NATIONAL HEALTH & WELFARE, CANADA, 1969
COPPER, As Cu	LT	0.01	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, As F ⁻	LT	1.2	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
HARDNESS, TOTAL, As CaCO ₃	LT	120	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, DISSOLVED, As Fe	LT	0.05	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, As Pb		ND	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MAGNESIUM, As Mg	LT	50	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
MANGANESE, As Mn	LT	0.01	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, As N	LT	10.0	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHORUS, TOT.INORG., As P	LT	0.2	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHATE, As SO ₄ ²⁻	LT	250	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TOTAL DISSOLVED SOLIDS	LT	500	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969
TURBIDITY	LE	1	JTU	NATIONAL HEALTH & WELFARE, CANADA, 1969
ZINC, As Zn	LT	1.0	mg/L	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 56

COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
OBJECTIVE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLY

PARAMETER	AMMONIA As N	CADMIUM As Cd	CALCIUM As Ca	COLOUR	COPPER As Cu	HARDNESS TOTAL As CaCO ₃
STATION	NONCOMPLIANT/INCLUDED VALUES					
10PE01CA0003	—	—	—	—	—	—
10PE01CA0004	1/1	3/8	—	2/16	6/6	—
10PE01CA0005	1/1	4/7	—	5/13	3/3	1/13
10PE01CB0010	—	—	—	—	1/2	6/6
10PE01CB0011	—	—	3/8	—	1/1	7/8
10PE01CB0012	—	—	—	—	—	—
10PE01CB0013	—	—	—	—	—	8/8
10PE01CB0014	—	—	—	—	1/2	7/8
10PE01CB0015	—	—	—	—	2/2	5/7
10PE01CB0016	1/1	2/8	—	1/16	5/5	—
10PE01CB0017	—	1/8	—	—	2/8	17/17
10PE01CC0012	—	—	—	—	3/3	7/9
10PE01CC0013	—	—	—	—	3/3	7/9
10PE01CC0014	—	1/3	—	—	1/3	6/9
10PE01CC0015	—	1/3	—	—	1/2	8/9
10PE01CC0016	—	1/3	—	—	—	1/8
10PE01CC0017	—	—	—	—	—	—
10PE01CC0018	—	—	—	—	1/2	—
10PE01CC0019	—	2/2	—	—	2/2	—
10PE01CC0020	—	—	—	—	1/2	1/8
10PE01CC0021	2/2	5/8	—	4/15	3/3	1/15
10PE01CC0022	—	3/6	—	1/13	5/5	—
10PE01CC0023	1/1	1/5	—	5/12	5/5	1/11
10PE01CC0024	3/3	3/7	—	7/13	5/5	—
10PE01CC0025	1/1	2/12	—	—	4/9	16/16
10PE01CD0001	2/2	3/9	—	8/15	5/6	4/15
10PE01CE0001	—	—	—	—	2/2	8/9
10PE01CE0002	—	—	—	—	1/2	8/8
10PE01CE0003	—	—	—	—	2/2	8/8
10PE01CE0004	1/1	2/3	—	—	—	7/9
10PE01CE0005	—	—	—	5/13	4/4	—
10PE01CE0006	—	—	—	—	—	—

TABLE 56 (CONCLUDED)

PARAMETER	IRON DISSOLVED As Fe	LEAD As Pb	MANGANESE As Mn	NITRATE + NITRITE As N	PHOSPHORUS TOT.INORG. As P	TURBIDITY
STATION	NONCOMPLIANT/INCLUDED VALUES					
10PE01CA0003	—	1/1	—	—	—	—
10PE01CA0004	—	7/7	1/1	—	1/8	16/16
10PE01CA0005	—	5/5	1/1	—	—	13/13
10PE01CB0010	—	1/2	—	—	—	—
10PE01CB0011	—	2/2	—	—	—	—
10PE01CB0012	—	1/2	—	—	—	—
10PE01CB0013	—	2/2	1/2	—	—	—
10PE01CB0014	—	2/2	—	4/8	—	—
10PE01CB0015	—	1/2	—	—	—	—
10PE01CB0016	—	6/6	—	—	1/7	14/16
10PE01CB0017	—	6/9	—	—	2/7	—
10PE01CC0012	—	3/3	—	—	—	—
10PE01CC0013	—	2/3	—	—	—	1/3
10PE01CC0014	—	2/3	—	—	—	1/3
10PE01CC0015	—	1/2	—	—	—	1/3
10PE01CC0016	—	1/2	—	—	—	1/3
10PE01CC0017	—	1/2	—	—	—	—
10PE01CC0018	—	2/2	—	—	—	—
10PE01CC0019	—	2/2	1/2	—	—	1/2
10PE01CC0020	—	1/2	—	—	—	—
10PE01CC0021	1/5	6/6	1/1	—	—	14/15
10PE01CC0022	—	7/7	—	—	2/7	6/13
10PE01CC0023	—	5/5	—	—	1/5	12/12
10PE01CC0024	—	7/7	1/1	—	2/7	13/13
10PE01CC0025	—	9/12	—	—	—	2/17
10PE01CD0001	—	7/8	1/1	—	1/9	14/15
10PE01CE0001	—	1/2	1/2	1/9	—	1/3
10PE01CE0002	—	1/2	—	1/8	—	—
10PE01CE0003	—	1/2	—	—	—	—
10PE01CE0004	—	3/3	—	—	—	—
10PE01CE0005	2/4	7/7	1/2	—	1/7	11/12
10PE01CE0006	—	6/10	—	—	—	—

TABLE 57

THE SATURATION INDEX

PARAMETER	LEVEL	REFERENCE
SATURATION INDEX	GE -0.75	MINES & TECH. SURV. CANADA, WAT. SURV. RPT. 1

TABLE 58

COMPLIANCE ANALYSIS OF
GROUNDWATER DATA IN RELATION TO
THE SATURATION INDEX

PARAMETER	SATURATION INDEX
STATION	NC/INCL*
10PE01CA0003	1/1
10PE01CA0004	3/14
10PE01CA0005	9/13
10PE01CB0010	—
10PE01CB0011	—
10PE01CB0012	—
10PE01CB0013	1/2
10PE01CB0014	2/2
10PE01CB0015	1/2
10PE01CB0016	8/14
10PE01CB0017	—
10PE01CC0012	1/3
10PE01CC0013	—
10PE01CC0014	—
10PE01CC0015	1/3
10PE01CC0016	2/3
10PE01CC0017	2/2
10PE01CC0018	1/2
10PE01CC0019	2/2
10PE01CC0020	2/2
10PE01CC0021	4/14
10PE01CC0022	3/13
10PE01CC0023	8/10
10PE01CC0024	8/12
10PE01CC0025	—
10PE01CD0001	8/14
10PE01CE0001	3/3
10PE01CE0002	—
10PE01CE0003	—
10PE01CE0004	—
10PE01CE0005	3/13
10PE01CE0006	1/14

* NONCOMPLIANT/INCLUDED VALUES

TABLE 59

GUIDELINES FOR LIVESTOCK WATERING

PARAMETER	LEVEL			REFERENCE
CALCIUM, As Ca	LE	1000	mg/L	AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
COPPER, As Cu	LE	0.5	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LE	0.1	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
NITRATE + NITRITE, As N	LE	100	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SULPHATE, As SO_4^{2-}	LE	1000	mg/L	AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
ZINC, As Zn	LE	25	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 60

GUIDELINES FOR LIVESTOCK WATERING

PARAMETER	LEVEL			REFERENCE
CADMIUM, As Cd	LE	0.050	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CALCIUM, As Ca	LE	1000	mg/L	AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
COPPER, As Cu	LE	0.5	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
FLUORIDE, As F^-	LE	2.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LE	0.1	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
NITRATE + NITRITE, As N	LE	100	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SULPHATE, As SO_4^{2-}	LE	1000	mg/L	AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
ZINC, As Zn	LE	25	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 61

**COMPLIANCE ANALYSIS OF
GROUNDWATER DATA IN RELATION TO
GUIDELINES FOR LIVESTOCK WATERING**

PARAMETER	LEAD As Pb
STATION	NC/INCL*
10PE01CA0003	—
10PE01CA0004	—
10PE01CA0005	—
10PE01CB0010	—
10PE01CB0011	—
10PE01CB0012	—
10PE01CB0013	—
10PE01CB0014	—
10PE01CB0015	—
10PE01CB0016	—
10PE01CB0017	—
10PE01CC0012	—
10PE01CC0013	—
10PE01CC0014	—
10PE01CC0015	—
10PE01CC0016	—
10PE01CC0017	—
10PE01CC0018	—
10PE01CC0019	—
10PE01CC0020	—
10PE01CC0021	2/6
10PE01CC0022	—
10PE01CC0023	—
10PE01CC0024	—
10PE01CC0025	—
10PE01CD0001	—
10PE01CE0001	—
10PE01CE0002	—
10PE01CE0003	—
10PE01CE0004	—
10PE01CE0005	—
10PE01CE0006	—

* NONCOMPLIANT/INCLUDED VALUES

TABLE 62

GUIDELINES FOR IRRIGATION OF ACIDIC SOILS

PARAMETER	LEVEL			REFERENCE
COPPER, As Cu	LE	0.20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
IRON, As Fe	LE	5.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LE	5.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	GE	4.5		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	LE	9.0		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SODIUM ABSORPTION RATIO	LT	8		AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
ZINC, As Zn	LE	2.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 63

GUIDELINES FOR IRRIGATION OF ACIDIC SOILS

PARAMETER	LEVEL			REFERENCE
CADMIUM, As Cd	LE	0.010	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COPPER, As Cu	LE	0.20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
FLUORIDE, As F ⁻	LE	1.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
IRON, As Fe	LE	5.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LE	5.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MANGANESE, As Mn	LE	0.20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	GE	4.5		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	LE	9.0		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SODIUM ABSORPTION RATIO	LT	8		AUSTRAL. WATER RESOURCES COUNCIL, TECH. PAPER 7
ZINC, As Zn	LE	2.0	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 64

**COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
GUIDELINES FOR IRRIGATION OF ACIDIC SOILS**

PARAMETER	CADMIUM As Cd	COPPER As Cu	IRON As Fe	MANGANESE As Mn
STATION	NONCOMPLIANT / INCLUDED VALUES			
10PE01CA0003	—	—	—	—
10PE01CA0004	—	—	1/7	—
10PE01CA0005	—	—	2/7	—
10PE01CB0010	—	—	—	—
10PE01CB0011	—	—	—	—
10PE01CB0012	—	—	—	—
10PE01CB0013	—	—	—	—
10PE01CB0014	—	—	—	—
10PE01CB0015	—	—	—	—
10PE01CB0016	—	—	1/8	—
10PE01CB0017	—	—	—	—
10PE01CC0012	—	—	—	—
10PE01CC0013	—	—	—	—
10PE01CC0014	—	—	—	—
10PE01CC0015	—	—	—	—
10PE01CC0016	—	—	—	—
10PE01CC0017	—	—	—	—
10PE01CC0018	—	—	—	—
10PE01CC0019	—	—	—	—
10PE01CC0020	—	—	—	—
10PE01CC0021	—	1/3	—	—
10PE01CC0022	—	—	—	—
10PE01CC0023	—	—	—	—
10PE01CC0024	—	—	—	—
10PE01CC0025	—	—	—	—
10PE01CD0001	1/9	1/6	—	—
10PE01CE0001	—	—	—	1/2
10PE01CE0002	—	—	—	—
10PE01CE0003	—	—	—	—
10PE01CE0004	—	—	—	—
10PE01CE0005	—	—	—	—
10PE01CE0006	—	—	—	—

TABLE 65

GUIDELINES FOR FOOD PROCESSING INDUSTRIES

PARAMETER	LEVEL			REFERENCE
ALKALINITY, As CaCO_3	LE	150	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
CHLORIDE, As Cl^-	LE	250	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
FLUORIDE, As F^-	LE	1	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
HARDNESS, As CaCO_3	LE	150	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
IRON, As Fe	LE	0.2	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
NITRATE, As N	LE	10	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
pH	GE	6.5		ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
pH	LE	8.5		ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SILICA, As SiO_2	LE	50	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SULPHATE, As SO_4^{2-}	LE	250	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SUSPENDED SOLIDS	LE	10	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
TOTAL DISSOLVED SOLIDS	LE	500	mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
TURBIDITY		ND	JTU	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974

TABLE 66

COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO GUIDELINES FOR FOOD PROCESSING INDUSTRIES

PARAMETER	IRON As Fe	pH	SUSPENDED SOLIDS	TURBIDITY
STATION	NONCOMPLIANT / INCLUDED VALUES			
00PE01CA0001	8/29	4.87	3/7	85/88
00PE01CB0001	14/27	—	8/12	70/71
00PE01CB0017	3/12	1/30	2/2	27/30
00PE01CE0001	13/25	2/83	—	81/85

TABLE 67

GUIDELINES FOR FOOD PROCESSING INDUSTRIES

PARAMETER		LEVEL	REFERENCE
ALKALINITY, As CaCO ₃	LE	150 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
CHLORIDE, As Cl ⁻	LE	250 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
FLUORIDE, As F ⁻	LE	1 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
HARDNESS, As CaCO ₃	LE	150 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
IRON, As Fe	LE	0.2 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
MANGANESE, As Mn	LE	0.2 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
NITRATE, As N	LE	10 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
pH	GE	6.5	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
pH	LE	8.5	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SILICA, As SiO ₂	LE	50 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SULPHATE, As SO ₄ ²⁻	LE	250 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
SUSPENDED SOLIDS	LE	10 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
TOTAL DISSOLVED SOLIDS	LE	500 mg/L	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974
TURBIDITY		ND JTU	ONTARIO, MINISTRY OF THE ENVIRONMENT, 1974

TABLE 68

COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
GUIDELINES FOR FOOD PROCESSING INDUSTRIES

PARAMETER	ALKALINITY As CaCO ₃	HARDNESS As CaCO ₃	IRON As Fe	MANGANESE As Mn	NITRATE As N	pH	SUSPENDED SOLIDS	TURBIDITY
STATION	NONCOMPLIANT/INCLUDED VALUES							
10PE01CA0003	1/6	—	—	—	—	—	—	1/1
10PE01CA0004	—	—	7/7	—	—	—	4/4	16/16
10PE01CA0005	—	—	7/7	—	—	—	3/3	13/13
10PE01CB0010	4/6	2/6	—	—	—	—	—	1/2
10PE01CB0011	6/8	7/8	—	—	—	—	—	2/2
10PE01CB0012	2/8	—	—	—	—	—	—	1/1
10PE01CB0013	2/8	2/8	1/2	—	—	—	—	2/2
10PE01CB0014	2/8	—	—	—	3/8	—	—	1/2
10PE01CB0015	2/8	—	—	—	—	—	—	2/2
10PE01CB0016	—	—	7/8	—	—	—	3/3	16/16
10PE01CB0017	—	10/17	1/6	—	—	—	—	8/17
10PE01CC0012	3/8	6/9	—	—	—	—	—	2/3
10PE01CC0013	2/9	—	1/3	—	—	—	1/1	3/3
10PE01CC0014	2/9	—	—	—	—	—	1/1	3/3
10PE01CC0015	2/9	6/9	—	—	—	—	1/1	2/3
10PE01CC0016	1/8	—	1/3	—	—	—	1/1	2/3
10PE01CC0017	2/8	—	—	—	—	—	—	2/2
10PE01CC0018	2/8	—	—	—	—	1/8	—	2/2
10PE01CC0019	—	—	2/2	—	—	—	—	2/2
10PE01CC0020	2/8	—	1/2	—	—	—	—	2/2
10PE01CC0021	—	—	6/7	—	—	—	4/4	15/15
10PE01CC0022	—	—	1/7	—	—	—	—	12/13
10PE01CC0023	—	—	1/5	—	—	—	2/2	12/12
10PE01CC0024	—	—	5/7	—	—	1/13	3/3	13/13
10PE01CC0025	3/17	11/16	—	—	—	—	—	10/17
10PE01CE0001	—	—	6/9	—	—	2/15	4/4	14/15
10PE01CE0001	8/9	8/9	—	1/2	1/9	1/9	—	3/3
10PE01CE0002	4/8	7/8	—	—	1/8	—	—	2/2
10PE01CE0003	2/8	2/8	—	—	—	—	—	2/2
10PE01CE0004	4/9	6/9	—	—	—	—	—	2/3
10PE01CE0005	—	—	5/7	—	—	—	3/3	12/12
10PE01CE0006	—	—	—	—	—	—	—	6/14

TABLE 69

GUIDELINES FOR ELECTRICAL UTILITIES (HIGH PRESSURE STEAM GENERATION)

PARAMETER	LEVEL	REFERENCE
ALKALINITY, As CaCO ₃	LE 1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BICARBONATE, As HCO ₃	LE 0.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CALCIUM, As Ca	LE 0.01 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COPPER, As Cu	LE 0.01 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
HARDNESS, TOTAL, As CaCO ₃	LE 0.07 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
IRON, As Fe	LE 0.01 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MAGNESIUM, As Mg	LE 0.01 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	GE 8.8	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	LE 9.4	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SUSPENDED SOLIDS	LE 0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
TOTAL DISSOLVED SOLIDS	LE 0.5 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LE 0.01 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 70

COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
GUIDELINES FOR ELECTRICAL UTILITIES (HIGH PRESSURE STEAM GENERATION)

PARAMETER	ALKALINITY As CaCO ₃	BI- CARBONATE As HCO ₃	CALCIUM As Ca	COPPER As Cu	HARDNESS TOTAL As CaCO ₃	IRON As Fe
STATION	NONCOMPLIANT/INCLUDED VALUES					
00PE01CA0001	86/86	86/86	84/84	1/11	37/37	29/29
00PE01CB0001	70/70	70/70	68/68	2/9	26/26	23/27
00PE01CB0017	30/30	30/30	30/30	1/12	30/30	12/12
00PE01CE0001	83/83	83/83	82/82	2/12	37/37	23/25

PARAMETER	MAGNESIUM As Mg	pH	SUSPENDED SOLIDS	TOTAL DISSOLVED SOLIDS	ZINC As Zn
STATION	NONCOMPLIANT/INCLUDED VALUES				
00PE01CA0001	29/29	87/87	7/7	81/81	3/11
00PE01CB0001	20/20	70/70	11/11	66/66	3/9
00PE01CB0017	24/24	30/30	2/2	30/30	6/11
00PE01CE0001	28/28	83/83	9/9	78/78	3/12

TABLE 71

GUIDELINES FOR ELECTRICAL UTILITIES (HIGH PRESSURE STEAM GENERATION)

PARAMETER	LEVEL			REFERENCE
ALKALINITY, As CaCO_3	LE	1	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
BICARBONATE, As HCO_3	LE	0.5	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
CALCIUM, As Ca	LE	0.01	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
COPPER, As Cu	LE	0.01	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
HARDNESS, TOTAL, As CaCO_3	LE	0.07	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
IRON, As Fe	LE	0.01	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MAGNESIUM, As Mg	LE	0.01	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MANGANESE, As Mn	LE	0.01	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	GE	8.8		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	LE	9.4		US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
SUSPENDED SOLIDS	LE	0.05	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
TOTAL DISSOLVED SOLIDS	LE	0.5	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LE	0.01	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 72

COMPLIANCE ANALYSIS OF GROUNDWATER DATA IN RELATION TO
GUIDELINES FOR ELECTRICAL UTILITIES (HIGH PRESSURE STEAM GENERATION)

PARAMETER	ALKALINITY As CaCO_3	BI- CARBONATE As HCO_3	CALCIUM As Ca	COPPER As Cu	HARDNESS TOTAL As CaCO_3	IRON As Fe
STATION	NONCOMPLIANT / INCLUDED VALUES					
10PE01CA0003	6/6	6/6	6/6	—	6/6	1/1
10PE01CA0004	16/16	16/16	16/16	6/6	16/16	7/7
10PE01CA0005	13/13	13/13	13/13	3/3	13/13	7/7
10PE01CB0010	6/6	6/6	6/6	1/2	6/6	2/2
10PE01CB0011	8/8	8/8	8/8	1/1	8/8	2/2
10PE01CB0012	8/8	8/8	8/8	—	8/8	2/2
10PE01CB0013	8/8	8/8	8/8	—	8/8	2/2
10PE01CB0014	8/8	8/8	8/8	1/2	8/8	2/2
10PE01CB0015	8/8	8/8	7/7	2/2	7/7	2/2
10PE01CB0016	16/16	16/16	14/14	5/5	14/14	8/8
10PE01CB0017	17/17	17/17	17/17	2/8	17/17	4/6
10PE01CC0012	8/8	8/8	9/9	3/3	9/9	3/3
10PE01CC0013	9/9	9/9	9/9	2/3	9/9	3/3
10PE01CC0014	9/9	9/9	9/9	1/3	9/9	2/3
10PE01CC0015	9/9	9/9	9/9	1/2	9/9	2/2
10PE01CC0016	8/8	8/8	8/8	—	8/8	3/3
10PE01CC0017	8/8	8/8	8/8	—	8/8	2/2
10PE01CC0018	8/8	8/8	8/8	1/2	8/8	1/2
10PE01CC0019	8/8	8/8	8/8	1/2	8/8	2/2
10PE01CC0020	8/8	8/8	8/8	1/2	8/8	2/2
10PE01CC0021	15/15	15/15	15/15	3/3	15/15	7/7
10PE01CC0022	13/13	13/13	13/13	5/5	13/13	7/7
10PE01CC0023	12/12	12/12	12/12	5/5	11/11	5/5
10PE01CC0024	13/13	13/13	13/13	5/5	13/13	7/7
10PE01CC0025	17/17	17/17	17/17	4/9	16/16	8/9
10PE01CE0001	15/15	15/15	15/15	5/6	15/15	9/9
10PE01CE0001	9/9	9/9	9/9	2/2	9/9	2/2
10PE01CE0002	8/8	8/8	8/8	—	8/8	2/2
10PE01CE0003	8/8	8/8	8/8	2/2	8/8	2/2
10PE01CE0004	9/9	9/9	9/9	—	9/9	3/3
10PE01CE0005	13/13	13/13	13/13	4/4	13/13	7/7
10PE01CE0006	14/14	14/14	14/14	—	14/14	6/6

TABLE 72 (CONCLUDED)

PARAMETER	MAGNESIUM As Mg	MANGANESE As Mn	pH	SUSPENDED SOLIDS	TOTAL DISSOLVED SOLIDS	ZINC As Zn
STATION	NONCOMPLIANT/INCLUDED VALUES					
10PE01CA0003	6/6	—	6/6	—	1/1	—
10PE01CA0004	16/16	1/1	16/16	4/4	14/14	3/3
10PE01CA0005	13/13	1/1	13/13	3/3	13/13	1/1
10PE01CB0010	6/6	—	6/6	—	2/2	1/1
10PE01CB0011	8/8	—	8/8	—	2/2	—
10PE01CB0012	8/8	—	8/8	—	2/2	2/2
10PE01CB0013	8/8	1/2	8/8	—	2/2	—
10PE01CB0014	8/8	—	8/8	—	2/2	1/1
10PE01CB0015	8/8	—	8/8	—	2/2	1/1
10PE01CB0016	16/16	—	16/16	3/3	14/14	2/2
10PE01CB0017	17/17	—	17/17	—	16/16	8/8
10PE01CC0012	9/9	—	9/9	—	3/3	—
10PE01CC0013	9/9	—	9/9	1/1	3/3	3/3
10PE01CC0014	9/9	—	9/9	1/1	3/3	2/2
10PE01CC0015	9/9	—	9/9	1/1	3/3	2/2
10PE01CC0016	8/8	—	8/8	1/1	3/3	2/2
10PE01CC0017	8/8	—	8/8	—	2/2	2/2
10PE01CC0018	8/8	—	8/8	—	2/2	2/2
10PE01CC0019	8/8	—	8/8	—	2/2	—
10PE01CC0020	8/8	—	8/8	—	2/2	—
10PE01CC0021	15/15	—	15/15	4/4	14/14	2/2
10PE01CC0022	13/13	—	13/13	—	13/13	3/3
10PE01CC0023	11/11	—	12/12	2/2	10/10	3/3
10PE01CC0024	13/13	1/1	13/13	3/3	12/12	2/2
10PE01CC0025	16/16	—	17/17	—	17/17	3/6
10PE01CE0001	15/15	1/1	15/15	4/4	15/15	3/3
10PE01CE0001	9/9	1/2	9/9	—	3/3	1/1
10PE01CE0002	8/8	—	8/8	—	2/2	2/2
10PE01CE0003	8/8	—	8/8	—	2/2	1/1
10PE01CE0004	9/9	—	9/9	—	3/3	—
10PE01CE0005	13/13	1/2	13/13	3/3	13/13	2/2
10PE01CE0006	14/14	—	14/14	—	14/14	10/10

TABLE 73

GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

PARAMETER	LEVEL			REFERENCE
ALKALINITY, As CaCO_3	GT	20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
COPPER, As Cu	LE	0.005	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
IRON, As Fe	LE	0.3	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
LEAD, As Pb	LE	0.03	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
pH	GE	6.5		US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	LE	9.0		US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ZINC, As Zn	LE	0.03	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976

TABLE 74

COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

PARAMETER	ALKALINITY As CaCO_3	COPPER As Cu	IRON As Fe	pH	ZINC As Zn
STATION	NONCOMPLIANT/INCLUDED VALUES				
00PE01CA0001	6/86	2/11	5/29	4/87	—
00PE01CB0001	2/70	3/9	6/27	—	—
00PE01CB0017	1/30	3/12	2/12	1/30	2/11
00PE01CE0001	—	4/12	4/25	1/83	3/12

TABLE 75

GUIDELINES FOR THE PROTECTION OF MARINE AQUATIC LIFE

PARAMETER	LEVEL		REFERENCE
ALDRIN	LE	0.003 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
γ -BHC (LINDANE)	LE	0.004 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
CADMIUM, As Cd	LE	0.005 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
α -CHLORDANE	LE	0.004 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
COPPER, As Cu	LT	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
p,p'-DDT	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
DIELDRIN	LE	0.003 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
α -ENDOSULFAN	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ENDRIN	LE	0.004 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
HEPTACHLOR	LE	0.001 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
IRON, As Fe	LT	0.3 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LT	0.05 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MANGANESE, As Mn	LE	0.10 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
p,p'-METHOXYCHLOR	LE	0.03 $\mu\text{g/L}$	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	GE	6.5	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	LE	8.5	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ZINC, As Zn	LT	0.1 mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 76

COMPLIANCE ANALYSIS OF ESTUARY WATER DATA IN RELATION TO
GUIDELINES FOR THE PROTECTION OF MARINE AQUATIC LIFE

DATA SET I

PARAMETER	CADMIUM As Cd	COPPER As Cu	p,p'-DDT	IRON As Fe	LEAD As Pb	MANGANESE As Mn	pH	ZINC As Zn
STATION	NONCOMPLIANT / INCLUDED VALUES							
02PE01CB0002	-	-	-	2/8	-	-	-	-
02PE01CB0003	-	-	-	-	-	-	-	-
02PE01CB0004	-	3/34	-	1/8	1/36	-	-	2/34
02PE01CB0005	-	7/27	1/1	2/8	1/28	-	-	1/26
02PE01CB0006	1/25	1/25	-	5/8	2/25	3/18	-	-
02PE01CB0007	1/20	1/18	-	-	2/19	-	-	1/18
02PE01CB0008	-	2/8	-	-	-	-	-	-
02PE01CC0001	-	11/33	-	-	1/36	-	-	-
02PE01CC0002	-	7/29	-	-	-	-	1/30	-
02PE01CC0003	-	1/14	-	1/8	-	1/10	-	-
02PE01CC0004	-	2/32	-	-	1/35	-	-	-
02PE01CC0005	-	-	-	-	-	1/7	-	-
02PE01CC0006	-	8/41	-	-	1/42	1/26	-	1/39
02PE01CC0007	-	4/38	-	-	-	2/25	3/40	-
02PE01CC0008	1/34	8/34	-	-	2/34	1/22	1/32	-
02PE01CC0009	-	-	-	-	-	-	-	-
02PE01CC0010	-	3/34	-	-	1/34	-	-	-
02PE01CC0011	-	3/26	-	-	-	-	-	-
02PE01CD0001	-	-	-	-	-	-	1/26	-
02PE01CD0002	-	2/26	-	-	-	-	-	1/25
02PE01CD0003	-	1/21	-	-	-	-	-	1/22
02PE01CD0004	-	-	-	-	-	-	-	-
02PE01CD0005	-	1/12	-	1/6	-	-	-	-
02PE01CD0006	-	1/14	-	-	-	-	1/14	-
02PE01CE0001	-	2/36	-	-	-	1/25	-	-
02PE01CE0002	-	4/38	-	2/8	2/40	-	1/40	1/39
02PE01CE0003	-	6/36	-	1/8	2/36	-	-	1/33
02PE01CE0004	-	-	-	-	-	-	-	-
02PE01CE0005	-	-	-	-	-	-	-	-
02PE01CE0006	-	5/28	-	-	2/28	-	-	1/26

TABLE 76 (CONCLUDED)

DATA SET II				
PARAMETER	CADMIUM As Cd	COPPER As Cu	LEAD As Pb	pH
STATION	NONCOMPLIANT / INCLUDED VALUES			
02PE01CA0002	—	3/10	—	—
02PE01CA0003	—	2/12	—	—
02PE01CA0004	—	1/10	—	—
02PE01CA0005	—	1/12	—	—
02PE01CA0006	—	—	—	—
02PE01CA0007	—	1/12	—	—
02PE01CA0008	—	1/10	—	—
02PE01CA0009	—	—	—	—
02PE01CA0010	—	1/6	—	—
02PE01CA0011	1/6	—	—	—
02PE01CA0013	—	—	—	1/6
02PE01CC0032	—	—	—	—
02PE01CC0033	—	—	—	—
02PE01CC0034	—	2/10	—	—
02PE01CC0035	—	2/10	—	—
02PE01CC0036	—	2/10	1/10	—
02PE01CC0037	—	—	—	—
02PE01CC0038	—	—	—	—
02PE01CE0007	—	2/18	—	—
02PE01CE0009	—	1/10	—	—
02PE01CE0010	—	—	—	1/10
02PE01CE0011	—	—	—	—
02PE01CE0012	—	—	—	—
02PE01CE0013	—	1/10	—	—
02PE01CE0014	1/10	1/10	—	—
02PE01CE0015	—	1/9	—	—
02PE01CE0016	—	1/10	—	—
02PE01CE0017	—	1/10	—	—
02PE01CE0018	—	1/9	—	—
02PE01CE0019	—	—	—	—

TABLE 77

GUIDELINES FOR THE PROTECTION OF MARINE AQUATIC LIFE

PARAMETER	LEVEL		REFERENCE
CADMIUM, As Cd	LE	0.005 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
COPPER, As Cu	LT	0.05 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LT	0.05 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
MANGANESE, As Mn	LE	0.10 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	GE	6.5	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
pH	LE	8.5	US ENVIRONMENTAL PROTECTION AGENCY, 440/9-76023
ZINC, As Zn	LT	0.1 mg/L	US ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 78

COMPLIANCE ANALYSIS OF OCEAN WATER DATA IN RELATION TO
GUIDELINES FOR THE PROTECTION OF MARINE AQUATIC LIFE

PARAMETER	COPPER As Cu	ZINC As Zn
STATION	NC/INCL*	
03PE01CA0001	1/7	—
03PE01CC0001	1/6	1/4
03PE01CE0001	2/10	1/9

* NONCOMPLIANT/INCLUDED VALUES

TABLE 79

GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

PARAMETER	LEVEL		REFERENCE
COPPER, As Cu	LT	0.005 mg/L	US, ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LT	0.01 mg/L	US, ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LT	0.02 mg/L	US, ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 80

COMPLIANCE ANALYSIS OF ESTUARY WATER DATA IN RELATION TO
GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

DATA SET I				DATA SET II			
PARAMETER	COPPER As Cu	LEAD As Pb	ZINC As Zn	PARAMETER	COPPER As Cu	LEAD As Pb	ZINC As Zn
STATION	NONCOMPLIANT/INCLUDED VALUES			STATION	NONCOMPLIANT/INCLUDED VALUES		
02PE01CB0002	3/8	—	5/7	02PE01CA0002	8/10	4/10	4/8
02PE01CB0003	2/8	2/8	7/8	02PE01CA0003	6/12	1/12	4/10
02PE01CB0004	15/34	7/36	17/34	02PE01CA0004	7/10	—	6/10
02PE01CB0005	13/27	9/28	11/26	02PE01CA0005	7/12	—	4/11
02PE01CB0006	8/25	7/25	11/24	02PE01CA0006	7/10	—	5/10
02PE01CB0007	11/18	8/19	12/18	02PE01CA0007	7/12	—	4/12
02PE01CB0008	4/8	1/8	5/8	02PE01CA0008	7/10	2/10	4/10
02PE01CC0001	15/33	18/36	12/28	02PE01CA0009	7/12	—	4/12
02PE01CC0002	14/29	8/30	8/27	02PE01CA0010	3/6	—	—
02PE01CC0003	4/14	1/14	3/14	02PE01CA0011	3/6	—	1/6
02PE01CC0004	12/32	9/35	8/34	02PE01CA0013	2/6	—	—
02PE01CC0005	1/8	—	2/8	02PE01CC0032	4/9	—	3/10
02PE01CC0006	22/41	13/42	16/39	02PE01CC0033	2/5	—	2/5
02PE01CC0007	15/38	15/40	13/37	02PE01CC0034	5/10	—	4/10
02PE01CC0008	15/34	9/34	15/33	02PE01CC0035	5/10	—	5/10
02PE01CC0009	5/13	—	5/14	02PE01CC0036	5/10	1/10	5/10
02PE01CC0010	16/34	6/34	13/34	02PE01CC0037	5/10	1/10	3/10
02PE01CC0011	19/26	12/26	11/26	02PE01CC0038	3/8	3/10	2/8
02PE01CD0001	8/25	2/26	10/25	02PE01CE0007	10/18	2/17	9/18
02PE01CD0002	10/26	2/25	9/25	02PE01CE0009	4/10	—	3/10
02PE01CD0003	9/21	—	9/22	02PE01CE0010	5/10	—	5/10
02PE01CD0004	10/25	4/26	8/25	02PE01CE0011	5/10	—	2/10
02PE01CD0005	1/12	2/13	1/12	02PE01CE0012	5/10	—	2/10
02PE01CD0006	6/14	—	7/14	02PE01CE0013	4/10	1/10	3/10
02PE01CE0001	15/36	5/37	9/35	02PE01CE0014	5/10	—	5/10
02PE01CE0002	12/38	8/40	12/39	02PE01CE0015	5/9	—	3/8
02PE01CE0003	15/36	9/36	9/33	02PE01CE0016	4/10	—	3/9
02PE01CE0004	1/8	—	3/8	02PE01CE0017	5/10	—	3/9
02PE01CE0005	—	—	—	02PE01CE0018	4/9	—	3/9
02PE01CE0006	10/28	10/28	6/26	02PE01CE0019	5/10	1/10	4/10

TABLE 81

GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

PARAMETER	LEVEL			REFERENCE
COPPER, As Cu	LT	0.005	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
LEAD, As Pb	LT	0.01	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
ZINC, As Zn	LT	0.02	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 82

COMPLIANCE ANALYSIS OF OCEAN WATER DATA IN RELATION TO
GUIDELINES FOR MINIMAL RISK OF ADVERSE EFFECTS TO MARINE AQUATIC LIFE

PARAMETER	COPPER As Cu	LEAD As Pb	ZINC As Zn
STATION	NONCOMPLIANT/INCLUDED VALUES		
03PE01CA0001	2/7	2/7	1/5
03PE01CC0001	5/6	1/6	3/4
03PE01CE0001	6/10	2/10	5/9

TABLE 83

GUIDELINES FOR POTENTIALLY HAZARDOUS NUTRIENT CONCENTRATIONS

PARAMETER	LEVEL		REFERENCE
NITROGEN, DISSOLVED, As N	LE	0.36 mg/L	U.S. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033
PHOSPHORUS, TOTAL, As P	LE	0.05 mg/L	U.S. ENVIRONMENTAL PROTECTION AGENCY, R3.73.033

TABLE 84

COMPLIANCE ANALYSIS OF ESTUARY WATER DATA IN RELATION TO
GUIDELINES FOR POTENTIALLY HAZARDOUS NUTRIENT CONCENTRATIONS

DATA SET I			DATA SET II		
PARAMETER	NITROGEN DISSOLVED As N	PHOSPHORUS TOTAL As P	PARAMETER	NITROGEN DISSOLVED As N	PHOSPHORUS TOTAL As P
STATION	NC/INCL*		STATION	NC/INCL*	
02PE01CB0002	—	—	02PE01CA0002	4/10	3/10
02PE01CB0003	—	1/8	02PE01CA0003	3/12	3/12
02PE01CB0004	1/34	4/36	02PE01CA0004	2/10	4/10
02PE01CB0005	8/27	8/27	02PE01CA0005	1/12	4/12
02PE01CB0006	14/25	15/25	02PE01CA0006	1/10	3/9
02PE01CB0007	1/18	—	02PE01CA0007	1/12	3/12
02PE01CB0008	—	2/8	02PE01CA0008	1/10	3/10
02PE01CC0001	—	2/36	02PE01CA0009	2/12	—
02PE01CC0002	—	4/30	02PE01CA0010	—	—
02PE01CC0003	—	—	02PE01CA0011	—	—
02PE01CC0004	—	3/35	02PE01CA0013	—	—
02PE01CC0005	—	—	02PE01CC0032	—	—
02PE01CC0006	3/42	8/42	02PE01CC0033	—	—
02PE01CC0007	3/40	7/40	02PE01CC0034	1/10	—
02PE01CC0008	—	3/34	02PE01CC0035	—	—
02PE01CC0009	—	2/14	02PE01CC0036	—	—
02PE01CC0010	—	2/34	02PE01CC0037	—	1/10
02PE01CC0011	—	2/26	02PE01CC0038	—	—
02PE01CD0001	2/26	5/26	02PE01CE0007	—	—
02PE01CD0002	—	1/26	02PE01CE0009	—	—
02PE01CD0003	—	—	02PE01CE0010	—	—
02PE01CD0004	—	—	02PE01CE0011	—	—
02PE01CD0005	—	—	02PE01CE0012	—	—
02PE01CD0006	—	—	02PE01CE0013	—	—
02PE01CE0001	2/37	5/37	02PE01CE0014	—	—
02PE01CE0002	2/40	13/40	02PE01CE0015	—	—
02PE01CE0003	—	3/36	02PE01CE0016	—	—
02PE01CE0004	—	—	02PE01CE0017	—	—
02PE01CE0005	—	—	02PE01CE0018	—	—
02PE01CE0006	—	—	02PE01CE0019	—	—

* NONCOMPLIANT/INCLUDED VALUES

TABLE 85

MAXIMUM PERMISSIBLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL		REFERENCE
ALDRIN	LE	17.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ -BHC (LINDANE)	LE	56.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORDANE	LE	3.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-DDT	LE	42.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
DIELDRIN	LE	17.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
ENDRIN	LE	1.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR	LE	18.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR EPOXIDE	LE	18.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-METHOXYCHLOR	LC	35.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 86

MAXIMUM PERMISSIBLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL		REFERENCE
ALDRIN	LE	17.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ -BHC (LINDANE)	LE	56.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORDANE	LE	3.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-DDT	LE	42.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
DIELDRIN	LE	17.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
ENDRIN	LE	1.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR	LE	18.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR EPOXIDE	LE	18.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-METHOXYCHLOR	LE	35.0 $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 87

OBJECTIVE AND ACCEPTABLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL		REFERENCE
ALDRIN	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
α -BHC	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ -BHC (LINDANE)	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
α -CHLORDANE	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ -CHLORDANE	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-DDT	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
DIELDRIN	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
ENDRIN	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR EPOXIDE	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-METHOXYCHLOR	ND	$\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 88

COMPLIANCE ANALYSIS OF STREAM WATER DATA IN RELATION TO
OBJECTIVE AND ACCEPTABLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	α -BHC	p,p'-DDT	ENDRIN	HEPTACHLOR	PARAMETER	α -BHC	p,p'-DDT	ENDRIN	HEPTACHLOR
STATION	NONCOMPLIANT/INCLUDED VALUES				STATION	NONCOMPLIANT/INCLUDED VALUES			
00PE01CA0001	—	—	—	—	00PE01CC0025	—	—	—	—
00PE01CB0001	—	—	—	—	00PE01CC0027	—	1/1	—	—
00PE01CB0006	—	—	—	—	00PE01CC0038	—	—	—	—
00PE01CB0017	—	—	—	—	00PE01CD0002	—	—	—	—
00PE01CB0018	—	—	—	—	00PE01CD0003	—	—	—	—
00PE01CB0019	—	—	—	—	00PE01CD0005	—	—	—	—
00PE01CB0020	—	—	—	—	00PE01CD0006	—	—	—	—
00PE01CB0023	—	—	—	—	00PE01CD0009	—	—	—	—
00PE01CB0025	—	—	—	—	00PE01CD0010	—	—	—	—
00PE01CB0026	—	—	—	—	00PE01CD0011	—	—	—	—
00PE01CB0028	—	—	—	—	00PE01CD0012	—	—	—	—
00PE01CB0029	—	—	—	—	00PE01CD0013	—	—	—	—
00PE01CB0030	—	—	—	—	00PE01CD0014	—	—	—	—
00PE01CB0031	—	—	—	—	00PE01CD0015	—	—	—	—
00PE01CB0032	—	—	—	—	00PE01CD0016	—	—	—	—
00PE01CB0034	—	—	—	—	00PE01CD0017	—	—	—	—
00PE01CB0035	—	—	—	—	00PE01CD0020	—	—	—	—
00PE01CB0036	—	—	—	—	00PE01CE0001	—	—	—	—
00PE01CB0037	1/1	—	—	—	00PE01CE0004	—	—	—	—
00PE01CC0002	—	—	—	—	00PE01CE0006	—	—	—	—
00PE01CC0004	—	—	—	—	00PE01CE0007	—	—	—	—
00PE01CC0005	—	—	—	—	00PE01CE0008	—	—	—	—
00PE01CC0009	—	—	—	—	00PE01CE0009	—	—	—	—
00PE01CC0010	—	—	—	—	00PE01CE0010	—	—	—	—
00PE01CC0012	—	—	1/1	—	00PE01CE0011	—	—	—	—
00PE01CC0013	—	—	—	—	00PE01CE0013	—	—	—	—
00PE01CC0014	—	—	—	—	00PE01CE0014	—	—	—	—
00PE01CC0015	—	—	—	—	00PE01CE0015	—	—	—	—
00PE01CC0016	—	—	—	—	00PE01CE0016	—	—	—	—
00PE01CC0018	—	—	—	—	00PE01CE0017	—	—	—	—
00PE01CC0019	—	—	—	1/1	00PE01CE0018	—	—	—	—
00PE01CC0020	—	—	—	—	00PE01CE0019	—	—	—	—
00PE01CC0022	—	—	—	—	00PE01CE0020	—	—	—	—
00PE01CC0023	—	—	—	—	01PE01CD0002	—	—	—	—
00PE01CC0024	—	—	—	—	01PE01CD0003	—	—	—	—
					01PE01CE0001	—	—	—	—

TABLE 89

OBJECTIVE AND ACCEPTABLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	LEVEL	REFERENCE
ALDRIN	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
α -BHC	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ -BHC (LINDANE)	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
α -CHLORDANE	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
γ -CHLORDANE	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-DDT	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
DIELDRIN	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
ENDRIN	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
HEPTACHLOR EPOXIDE	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969
p,p'-METHOXYCHLOR	ND $\mu\text{g/L}$	NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 90

COMPLIANCE ANALYSIS OF ESTUARY WATER DATA IN RELATION TO
OBJECTIVE AND ACCEPTABLE LEVELS OF PESTICIDES IN RAW WATER

PARAMETER	α -BHC	p,p'-DDT	HEPTACHLOR	PARAMETER	α -BHC	p,p'-DDT	HEPTACHLOR
STATION	NONCOMPLIANT / INCLUDED VALUES			STATION	NONCOMPLIANT / INCLUDED VALUES		
02PE01CA0001	1/3	—	—	02PE01CC0030	—	—	—
02PE01CA0002	—	—	—	02PE01CC0031	—	—	—
02PE01CA0003	—	—	—	02PE01CC0032	—	—	—
02PE01CA0004	—	—	—	02PE01CC0033	—	—	—
02PE01CA0005	—	—	—	02PE01CC0034	—	—	—
02PE01CA0006	—	—	—	02PE01CC0035	—	—	—
02PE01CA0007	—	—	—	02PE01CC0036	—	—	—
02PE01CA0008	—	—	—	02PE01CC0037	—	—	—
02PE01CA0009	—	—	—	02PE01CC0038	—	—	—
02PE01CA0010	—	—	—	02PE01CC0045	—	—	—
02PE01CA0011	—	—	—	02PE01CC0047	—	—	—
02PE01CA0013	—	—	—	02PE01CC0049	—	—	1/1
02PE01CB0001	2/5	1/5	—	02PE01CC0050	—	—	—
02PE01CB0002	2/5	—	—	02PE01CC0051	—	—	—
02PE01CB0003	3/5	—	—	02PE01CC0052	—	—	—
02PE01CB0004	3/6	—	—	02PE01CC0054	—	—	—
02PE01CB0005	3/6	1/6	—	02PE01CD0001	3/6	—	—
02PE01CB0006	1/6	—	—	02PE01CD0002	1/6	—	—
02PE01CB0007	1/1	—	—	02PE01CD0003	2/6	—	—
02PE01CB0008	—	—	—	02PE01CD0004	2/6	—	—
02PE01CB0014	—	—	—	02PE01CD0005	—	—	—
02PE01CB0017	—	—	—	02PE01CD0006	1/4	—	—
02PE01CC0001	2/4	—	—	02PE01CD0011	—	—	—
02PE01CC0002	3/4	—	—	02PE01CD0012	—	—	—
02PE01CC0003	2/4	—	—	02PE01CD0013	—	—	—
02PE01CC0004	4/4	—	—	02PE01CE0001	1/4	—	—
02PE01CC0005	1/3	—	—	02PE01CE0002	1/5	—	—
02PE01CC0006	3/4	—	—	02PE01CE0003	4/6	—	—
02PE01CC0007	3/4	—	—	02PE01CE0004	3/4	—	—
02PE01CC0008	3/3	—	—	02PE01CE0005	3/4	—	—
02PE01CC0009	3/3	—	—	02PE01CE0006	5/5	—	—
02PE01CC0010	4/4	—	—	02PE01CE0007	—	—	—
02PE01CC0011	—	—	—	02PE01CE0009	—	—	—
02PE01CC0012	—	—	—	02PE01CE0010	—	—	—
02PE01CC0013	—	—	—	02PE01CE0011	—	—	—
02PE01CC0014	—	—	—	02PE01CE0012	—	—	—
02PE01CC0015	—	—	—	02PE01CE0013	—	—	—
02PE01CC0016	—	—	—	02PE01CE0014	—	—	—
02PE01CC0017	—	—	—	02PE01CE0015	—	—	—
02PE01CC0019	—	—	—	02PE01CE0016	—	—	—
02PE01CC0020	—	—	—	02PE01CE0017	—	—	—
02PE01CC0021	—	—	—	02PE01CE0018	—	—	—
02PE01CC0022	—	—	—	02PE01CE0019	—	—	—
02PE01CC0023	—	—	—	02PE01CE0020	—	—	—
02PE01CC0024	—	—	—	02PE01CE0021	—	—	—
02PE01CC0025	—	—	—	02PE01CE0022	—	—	—
02PE01CC0026	—	—	—	02PE01CE0040	—	—	—
02PE01CC0027	—	—	—	02PE01CE0045	—	—	—
02PE01CC0028	—	—	—	02PE01CE0046	—	—	—
02PE01CC0029	—	—	—				

TABLE 91

'STANDARD SEAWATER' CONCENTRATIONS

PARAMETER	LEVEL		REFERENCE
CADMIUM, As Cd		ND mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
CALCIUM, As Ca	GE	400. mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
CHLORIDE, As Cl ⁻	GT	19 000. mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
COPPER, As Cu	LE	0.003 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
IRON, As Fe	LE	0.01 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
LEAD, As Pb		ND mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
MAGNESIUM, As Mg	GE	1350 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
MANGANESE, As Mn	LE	0.002 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
PHOSPHORUS, TOT.INORG., As P	LE	0.7 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
POTASSIUM, As K	GE	380. mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
SODIUM, As Na	GT	10 500. mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
SULPHATE, As SO ₄ ²⁻	GE	885. mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
ZINC, As Zn	LE	0.01 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY

TABLE 92

COMPARISON OF ESTUARY WATER DATA TO
'STANDARD SEAWATER' CONCENTRATIONS

PARAMETER	MANGANESE As Mn	PHOSPHORUS TOT INORG. As P	POTASSIUM As K	SODIUM As Na	SULPHATE As SO ₄ ²⁻	ZINC As Zn
STATION	NONCOMPLIANT / INCLUDED VALUES					
02PE01CA0002	3/3	—	—	—	—	6/8
02PE01CA0003	2/2	—	—	—	—	4/10
02PE01CA0004	3/3	—	—	—	—	7/10
02PE01CA0005	2/2	—	—	—	—	6/11
02PE01CA0006	4/4	—	—	—	—	7/10
02PE01CA0007	3/3	—	—	—	—	5/12
02PE01CA0008	3/3	—	—	—	—	6/10
02PE01CA0009	4/4	—	—	—	—	7/12
02PE01CA0010	2/2	—	—	—	—	2/5
02PE01CA0011	—	—	—	—	—	3/6
02PE01CA0013	—	—	—	—	—	2/6
02PE01CB0002	6/7	—	2/8	8/8	2/8	5/7
02PE01CB0003	6/6	—	2/8	8/8	2/8	7/8
02PE01CB0004	12/12	—	2/8	7/7	—	24/34
02PE01CB0005	16/16	—	7/8	8/8	2/22	15/26
02PE01CB0006	14/14	—	8/8	8/8	7/17	19/24
02PE01CB0007	5/5	—	—	—	—	13/18
02PE01CB0008	—	—	—	—	—	5/8
02PE01CC0001	20/20	—	4/8	8/8	—	15/28
02PE01CC0002	20/20	—	2/8	8/8	—	16/27
02PE01CC0003	10/10	—	3/8	8/8	—	5/14
02PE01CC0004	16/16	—	2/8	8/8	—	14/34
02PE01CC0005	7/7	—	2/8	8/8	—	4/8
02PE01CC0006	18/18	—	3/8	8/8	1/26	19/39
02PE01CC0007	16/16	—	5/8	8/8	2/23	18/37
02PE01CC0008	14/14	—	2/6	6/6	—	16/33
02PE01CC0009	6/6	—	2/6	6/6	—	6/14
02PE01CC0010	17/17	—	3/8	8/8	—	20/34
02PE01CC0011	9/9	—	—	—	1/18	16/26
02PE01CC0032	4/4	—	—	—	—	4/10
02PE01CC0033	1/1	—	—	—	—	3/5
02PE01CC0034	4/4	—	—	—	—	6/10
02PE01CC0035	4/4	—	—	—	—	6/10
02PE01CC0036	3/3	—	—	—	—	8/10
02PE01CC0037	3/3	—	—	—	—	5/10
02PE01CC0038	—	—	—	—	—	4/8
02PE01CD0001	4/4	1/26	4/6	6/6	1/13	14/25
02PE01CD0002	4/4	—	4/6	6/6	—	12/25
02PE01CD0003	2/2	—	4/6	6/6	—	13/22
02PE01CD0004	6/6	—	4/6	6/6	—	13/25
02PE01CD0005	2/2	—	4/6	6/6	—	2/12
02PE01CD0006	1/1	—	2/4	4/4	—	8/14
02PE01CE0001	16/16	—	3/6	7/7	2/23	14/35
02PE01CE0002	13/13	—	6/8	8/8	5/24	16/39
02PE01CE0003	14/14	—	4/8	8/8	1/22	16/33
02PE01CE0004	5/5	—	4/8	8/8	—	5/8
02PE01CE0005	7/7	—	5/8	8/8	—	1/8
02PE01CE0006	10/11	—	4/8	8/8	—	8/26
02PE01CE0007	2/2	—	—	—	—	11/18
02PE01CE0009	2/2	—	—	—	—	4/10
02PE01CE0010	2/2	—	—	—	—	6/10
02PE01CE0011	1/1	—	—	—	—	5/10
02PE01CE0012	1/1	—	—	—	—	6/10
02PE01CE0013	1/1	—	—	—	—	4/10
02PE01CE0014	1/1	—	—	—	—	5/10
02PE01CE0015	3/3	—	—	—	—	6/8
02PE01CE0016	2/2	—	—	—	—	4/9
02PE01CE0017	1/1	—	—	—	—	4/9
02PE01CE0018	1/1	—	—	—	—	6/9
02PE01CE0019	2/2	—	—	—	—	5/10

TABLE 92 (CONCLUDED)

PARAMETER	CADMIUM As Cd	CALCIUM As Ca	CHLORIDE As Cl ⁻	COPPER As Cu	IRON As Fe	LEAD As Pb	MAGNESIUM As Mg
STATION	NONCOMPLIANT / INCLUDED VALUES						
02PE01CA0002	3/10	—	—	8/10	—	10/10	10/10
02PE01CA0003	7/12	—	—	7/12	—	10/12	12/12
02PE01CA0004	1/10	—	—	7/10	—	9/10	10/10
02PE01CA0005	7/12	—	—	7/12	—	12/12	12/12
02PE01CA0006	2/10	—	—	7/10	—	9/10	10/10
02PE01CA0007	6/12	—	—	7/12	—	11/12	12/12
02PE01CA0008	4/10	—	—	7/10	—	10/10	10/10
02PE01CA0009	2/12	—	—	7/12	—	10/12	12/12
02PE01CA0010	1/6	—	—	3/6	—	6/6	6/6
02PE01CA0011	4/6	—	—	3/6	—	6/6	6/6
02PE01CA0013	3/6	—	—	2/6	—	6/6	6/6
02PE01CB0002	4/8	6/8	8/8	3/8	8/8	3/8	8/8
02PE01CB0003	2/8	6/8	8/8	3/8	8/8	5/8	8/8
02PE01CB0004	14/36	6/8	8/8	15/34	8/8	31/36	36/36
02PE01CB0005	10/28	6/8	8/8	14/27	8/8	24/28	27/27
02PE01CB0006	9/25	8/8	8/8	11/25	8/8	21/25	24/24
02PE01CB0007	9/20	—	—	11/18	—	19/19	20/20
02PE01CB0008	3/8	—	—	4/8	—	8/8	8/8
02PE01CC0001	16/36	8/8	8/8	16/33	8/8	35/36	36/36
02PE01CC0002	10/30	6/8	8/8	14/29	8/8	30/30	30/30
02PE01CC0003	4/14	7/8	8/8	4/14	8/8	12/14	14/14
02PE01CC0004	17/35	6/8	8/8	15/32	8/8	30/35	35/35
02PE01CC0005	1/8	6/8	8/8	2/8	7/8	2/8	8/8
02PE01CC0006	19/42	7/8	8/8	22/41	8/8	36/42	42/42
02PE01CC0007	13/40	6/8	8/8	17/38	8/8	36/40	40/40
02PE01CC0008	9/34	6/6	6/6	16/34	6/6	30/34	34/34
02PE01CC0009	2/14	6/6	6/6	5/13	6/6	11/14	14/14
02PE01CC0010	14/34	7/8	8/8	16/34	8/8	28/34	34/34
02PE01CC0011	7/26	—	—	19/26	—	26/26	26/26
02PE01CC0032	2/10	—	—	4/9	—	9/10	10/10
02PE01CC0033	1/5	—	—	3/5	—	5/5	5/5
02PE01CC0034	2/10	—	—	6/10	—	8/10	10/10
02PE01CC0035	2/10	—	—	5/10	—	9/10	10/10
02PE01CC0036	3/10	—	—	5/10	—	9/10	10/10
02PE01CC0037	3/10	—	—	5/10	—	10/10	10/10
02PE01CC0038	4/10	—	—	4/8	—	9/10	10/10
02PE01CD0001	11/26	6/6	6/6	10/25	6/6	25/26	25/26
02PE01CD0002	10/26	6/6	6/6	10/26	6/6	24/25	26/26
02PE01CD0003	9/22	6/6	6/6	10/21	6/6	21/22	22/22
02PE01CD0004	9/26	6/6	6/6	10/25	6/6	23/26	26/26
02PE01CD0005	3/13	6/6	6/6	1/12	6/6	12/13	13/13
02PE01CD0006	4/14	4/4	4/4	6/14	4/4	13/14	14/14
02PE01CE0001	18/37	7/7	7/7	15/36	7/7	34/37	38/38
02PE01CE0002	19/40	8/8	8/8	13/38	8/8	38/40	40/40
02PE01CE0003	20/36	8/8	8/8	18/36	8/8	35/36	36/36
02PE01CE0004	3/8	8/8	8/8	1/8	8/8	7/8	8/8
02PE01CE0005	2/8	7/8	8/8	1/8	8/8	7/7	8/8
02PE01CE0006	12/28	8/8	8/8	10/28	8/8	27/28	28/28
02PE01CE0007	6/18	—	—	10/18	—	15/17	18/18
02PE01CE0009	5/10	—	—	6/10	—	10/10	10/10
02PE01CE0010	4/10	—	—	5/10	—	10/10	10/10
02PE01CE0011	4/10	—	—	5/10	—	10/10	10/10
02PE01CE0012	4/10	—	—	5/10	—	9/10	10/10
02PE01CE0013	5/10	—	—	4/10	—	10/10	10/10
02PE01CE0014	5/10	—	—	5/10	—	9/10	10/10
02PE01CE0015	5/9	—	—	5/9	—	9/9	9/9
02PE01CE0016	6/10	—	—	4/10	—	10/10	10/10
02PE01CE0017	5/10	—	—	6/10	—	10/10	10/10
02PE01CE0018	5/9	—	—	4/9	—	9/9	9/9
02PE01CE0019	7/10	—	—	5/10	—	10/10	10/10

TABLE 93

'STANDARD SEAWATER' CONCENTRATIONS

PARAMETER		LEVEL	REFERENCE
CADMIUM, As Cd		ND mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
COPPER, As Cu	LE	0.003 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
LEAD, As Pb		ND mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
MAGNESIUM, As Mg	GE	1350 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
MANGANESE, As Mn	LE	0.002 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
PHOSPHORUS, TOT.INORG., As P	LE	0.7 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY
ZINC, As Zn	LE	0.01 mg/L	HORNE, R.A. (1969), MARINE CHEMISTRY

TABLE 94

COMPARISON OF OCEAN WATER DATA TO
'STANDARD SEAWATER' CONCENTRATIONS

PARAMETER	CADMIUM As Cd	COPPER As Cu	LEAD As Pb	MAGNESIUM As Mg	MANGANESE As Mn	ZINC As Zn
STATION	NONCOMPLIANT/INCLUDED VALUES					
03PE01CA0001	3/7	2/7	6/7	7/7	—	1/5
03PE01CC0001	2/6	5/6	6/6	6/6	2/2	3/4
03PE01CE0001	6/10	7/10	10/10	9/9	1/1	5/9

Appendix II

Parameter Descriptions

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Parameter Descriptions

ALKALINITY

Alkalinity is a measure of a water's capacity to neutralize an acid. It indicates the presence of carbonates, bicarbonates, and hydroxides, and less significantly, borates, silicates, phosphates, and organic substances. It is expressed as an equivalent of calcium carbonate (CaCO_3). The species composition of alkalinity is affected by pH, mineral composition, temperature, and ionic strength, however, alkalinity is normally interpreted as a function of carbonates, bicarbonates, and hydroxides.

Environmental Range

Alkalinity concentrations vary with discharge. Higher alkalinity values are usually associated with low discharge. Alkalinity values in natural surface waters rarely exceed 500 mg/L. For the majority of Canadian surface waters, alkalinity is usually due to bicarbonates of alkaline earths, and attributable to carbonate hardness.

Water Quality Guidelines

Waters with high alkalinity are undesirable because of the associated excessive hardness or high concentrations of sodium salts. Guidelines on water quality have been established to ensure capability of water treatment processes to maintain a chemical balance of water; to alleviate corrosive or encrusting properties; and to eliminate human health problems such as gastrointestinal irritation. The acceptable range of alkalinity for drinking waters has been set from 30-500 mg/L (Dep. of Nat. Health & Welfare, 1969).

To protect the aquatic environment, guidelines stipulate that alkalinity must be maintained at natural background levels with no sudden variations (Environ. Stud. Bd., 1973).

Effects on Use

When waters with high alkalinity are boiled over an extended time period, either a deposit may be formed or

an unpleasant taste is created depending upon chemical reaction. Waters with very low alkalinity corrode pipes and plumbing. Alkalinity values are important in water and wastewater practices, and difficulties may be encountered in treatment of waters with high alkalinity.

CADMIUM

Cadmium and its compounds are usually only present in waters in trace quantities. Elemental cadmium is insoluble in water, and cadmium carbonate and hydroxide have low solubilities. Cadmium salts (chlorides, nitrates, or sulphates) may be present as organic and inorganic complexes or adsorbed on suspended particles or bottom sediments. At high pH, cadmium precipitates from solution. The toxicity of this element is dependent on the pH and hardness of the water. The presence of zinc and cyanide affect the potential toxicity of cadmium. Zinc and lead are closely associated with cadmium in the natural environment.

Environmental Range

Natural waters contain only traces of cadmium, in the range of 0.0001 to 0.010 mg/L. Seawater concentration of cadmium is typically 0.0001 mg/L. Elevated concentrations above these natural levels can be attributed to anthropogenic sources.

Sources

Cadmium may be found as its sulphide (greenockite) and is associated with sulphide ores, especially sphalerite (zinc sulphide).

Anthropogenic sources of cadmium are significant. Electroplating operations and primary copper and nickel production may release cadmium to the environment. The combustion of fossil fuels may release cadmium to the atmosphere and thus cadmium could enter waters by

precipitation. Since cadmium protects other metals against oxidation, it is used in various alloys. It is also used in the manufacture of pigments, nickel cadmium storage batteries, solders, electronics, lubricants, photography, glass ceramics, some biocides, superphosphate fertilizers and as a stabilizer in plastics. The deterioration of galvanized materials can add cadmium to the environment.

Water Quality Guidelines

Cadmium has a cumulative and highly toxic effect on man in all its chemical forms. Adverse effects occur in the arteries, kidneys, and lungs. Initial symptoms may be cramps, nausea, vomiting, and diarrhea. Diet affects cadmium's toxicity; a low protein diet is associated with increases in potential toxicity. Raw and drinking waters should not exceed 0.01 mg/L of cadmium (Dep. of the Environ., 1972; Dep. of Nat. Health & Welfare, 1969).

Similar to man livestock are subject to adverse effects from the accumulation of cadmium. To provide an adequate margin of safety, waters used for watering of livestock should not exceed 0.05 mg/L (Environ. Stud. Bd., 1973; Agri. Canada).

The aquatic environment is sensitive to high cadmium concentrations. The toxicity to fish varies with species and time of exposure. Trout and zooplankton are particularly sensitive, since cadmium affects reproduction. There is, however, little evidence of bioaccumulation of cadmium in the food chain. Other heavy metals such as zinc and copper increase cadmium's toxicity. To protect aquatic life, a maximum concentration of cadmium has been set at 0.0002 mg/L (Gt. Lakes Wat. Qual. Bd., 1976a).

Since the presence of cadmium has been shown to reduce plant growth and since it accumulates within the structure of the plant, which may subsequently be used as a food source, limits of cadmium in irrigation waters have been proposed. Concentrations in irrigation waters used on neutral or alkaline soils should not exceed 0.05 mg/L whereas concentrations in irrigation waters on acid soils should not exceed 0.01 mg/L, (Environ. Stud. Bd., 1973).

Effects on Use

The presence of cadmium may restrict the use of water as a source for drinking and may also have deleterious effects on the aquatic environment.

CALCIUM

Calcium is one of the alkaline-earth metals and one of the most abundant cations in surface and groundwaters. Since calcium is relatively abundant in the earth's crust and is readily soluble in water, calcium ions and salts are frequently encountered in water. Calcium compounds are stable in water in the presence of carbon dioxide. When groundwater rises to the surface, the subsequent rise in temperature or reduction in pressure causes degassing of carbon dioxide and precipitation of a calcium salt. Calcium along with magnesium is primarily responsible for the hardness of a water.

Environmental Range

The presence of calcium in fresh waters varies according to the proximity of natural sources. Typical calcium concentrations are less than 10 mg/L, while waters proximal to carbonate rocks may be in the range from 30 to 100 mg/L. Waters in contact with gypsiferous shale may exhibit a calcium concentration of several hundred milligrams per litre, seawater concentrations usually are 400 mg/L, and brines may contain up to 75 000 mg/L.

Sources

Calcium may be readily dissolved from many rocks and leached from soils. Silicate minerals such as the pyroxenes, amphiboles, and sedimentary deposits of calcite and dolomite, gypsum and the mineral apatite may release substantial amounts of calcium into solution.

Anthropogenic contributions of calcium to water may be from sewage or industrial wastes. Some industrial contributions of calcium may be by chemical plants, by the brewing industry, and in the manufacture of glue. The practice of road salting contributes calcium to waters.

Water Quality Guidelines

Calcium is essential to human nutrition, aids in maintaining the structure of plant cells, and is desirable for irrigation because it aids in soil structure. High concentrations of calcium in water are relatively harmless to all organisms and may reduce toxicity of certain chemical compounds to fish.

Although insufficient amounts of calcium may induce adverse physiological effects, calcium may predispose the

body to the formation of concretions, such as kidney or bladder stones, and irritate urinary passages. Concentrations of 1 800 mg/L of calcium in drinking water have proven harmless.

Objectives for calcium in drinking water have been established not for health concerns but rather due to the adverse effects of calcium as it contributes to a water's hardness. An objective of less than 200 mg/L has been proposed for waters used for drinking with optimal concentrations less than 75 mg/L (Dep. of Nat. Health & Welfare, 1969).

Drinking waters used for livestock may contain as much as 1 000 mg/L but should magnesium be present a limit of 700 mg/L for beef cattle has been proposed (Hart, 1974).

Effects on Use

Calcium contributes to the hardness of water and thereby restricts a water's use as a drinking water source. Consult the section on hardness for further discussion.

CARBON

Total Organic Carbon

Total organic carbon is composed of both dissolved and particulate organic carbon, with dissolved to particulate forms occurring in the ratio of 10 to 1. Total organic carbon is often calculated as the difference between total carbon and total inorganic carbon. It bears a direct relationship with both the biochemical and chemical oxygen demands and varies with the composition of organic carbon present. The bulk of organic carbon in water is composed of humic substances and partly degraded plant and animal materials and is resistant to microbial degradation. Photosynthetic activities contribute dissolved organic carbon to aquatic systems. The amounts of organic components vary with discharge and especially with the growth cycles of vegetation.

Environmental Range

The total organic content in natural waters may vary from 1 to 30 mg/L. Higher values result from anthropogenic inputs.

Sources

Organic carbon compounds may be formed by

photosynthesis within the aquatic environment. Plant and animal materials contribute organic carbon to the aquatic environment. Runoff from agricultural lands and municipal and industrial waste discharges, from the pulp and paper industry, may further contribute to the total organic carbon in water.

Water Quality Guidelines

The decomposition of carbon compounds removes oxygen from a water and excess amounts can lower dissolved oxygen to levels below that required by aquatic organisms. Carbon is a nutrient for biological processes and a component of protoplasm.

No guidelines have been established for total organic carbon because it encompasses complex organic compounds, however, waters containing less than 3.0 mg/L total organic carbon are judged relatively clean (Environ. Canada, 1977).

Total organic carbon values can be used to assess efficiencies of waste treatment.

Effects on Use

None.

Total Inorganic Carbon

Total inorganic carbon is primarily composed of the sum of carbonates, bicarbonates, and carbonic acid. Total inorganic carbon is determined as an operational parameter; without information on speciation this parameter cannot be meaningfully interpreted. The sum of total inorganic carbon and total organic defines the total carbon content of a water. Consult sections on carbonates, bicarbonates, and organic carbon for further discussion.

CARBONATE-BICARBONATE

The carbonate-bicarbonate system in natural waters is part of the carbon cycle of the biosphere. In natural waters, the carbonate and bicarbonate ions and carbonic acid are maintained in equilibrium. The bicarbonate ions serve as the main buffer in aqueous freshwater systems and provide carbon dioxide for photosynthesis.

The relative amounts of carbonates, bicarbonates and carbonic acid are dependent on the pH of the water. Figure 1 shows the species composition of inorganic carbon.

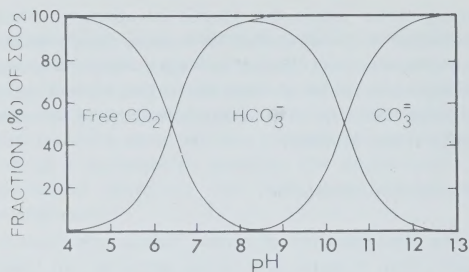


Figure 1. Speciation of inorganic carbon. Source: Wetzel, 1975, p. 163.

It should be noted that this figure represents the speciation of inorganic carbon present in fresh water, *not* absolute quantities.

Environmental Range

Carbonate concentrations are virtually absent in surface waters as pH values rarely exceed 9 units; groundwaters may be more alkaline and contain 10 mg/L carbonates. Atypical waters with high sodium content may contain 50 mg/L carbonates.

At 7 to 8 pH, which is typically encountered in many freshwater streams, the bicarbonate ions will predominate constituting from 60 to 90 per cent of total inorganic carbon. The bicarbonate concentrations in surface waters are usually less than 500 mg/L and frequently less than 25 mg/L.

The concentration of total inorganic carbon in surface waters is normally higher during low discharge periods due to greater groundwater influence.

Sources

Inorganic carbon in the aqueous system can be obtained from the carbon dioxide in the atmosphere, and by biotic respiration. Water in contact with carbonate rocks such as limestones and dolomites contribute bicarbonates and carbonates to the aquatic system.

Bicarbonate salts are used in industry because of their high solubility and may be found concentrated in industrial waste effluent.

Water Quality Guidelines

Limits to concentrations of carbonates and bicarbon-

ates in waters have not been established, but criteria on alkalinity values have been proposed. Refer to section on alkalinity for guidelines.

Effects on Use

The presence of bicarbonates and carbonates in water is undesirable for municipal water supplies and objectionable to a variety of industries. Upon heating carbonates and bicarbonates combine with calcium and magnesium to form a scale on metal surfaces. These problems are discussed further in the section on hardness. Other characteristics detrimental to use are discussed in the section on alkalinity.

CHLORIDE

Chloride is a major inorganic anion and is present in variable concentrations in natural waters. Since typical freshwater concentrations range in milligrams per litre, chloride is considered to be a major ion. Most chlorides are very soluble and their presence may impart a distinctive salty taste depending upon the chemical composition of the water.

Environmental Range

Concentrations of chloride vary by climatic regions with surface waters in humid regions exhibiting low chloride concentrations (<10 mg/L), whereas waters in semi-arid and arid regions contain as much as several hundred milligrams per litre. "Standard" seawater may have as much as 19 300 mg/L and brines may contain up to 200 000 mg/L. High chloride concentrations are not usually found in Canadian inland surface waters, but may occur at the freshwater-seawater interface in estuaries. Airborne ocean spray and saltwater intrusions into aquifers may increase chloride concentrations in coastal fresh waters, including groundwaters.

Sources

Chlorides may be found in sulphates and in calcareous deposits. Weathering and leaching of sedimentary rocks and soils provide chlorides to water. Domestic sewage discharge, municipal storm drainage, and industrial wastes provide a substantial input of chlorides. Household cleansers and salting of roads in winter are two other common sources.

Water Quality Guidelines

No adverse human health effects result from the presence of large quantities of chloride (600 mg/L); limits to the maximum concentration have, however, been set due to taste preferences. Most industrial, domestic, and agricultural uses require chloride concentrations of less than 250 mg/L.

Changes in the chloride concentrations of a water may cause a shift in the biotic community, but no recommendations to protect aquatic life have been set.

Effects on Use

Large amounts of chloride, where calcium and magnesium are also present, increase a water's corrosiveness and may adversely affect metallic equipment. Seawater, with its high concentrations of chloride, is particularly corrosive. Chlorides are not removed by filtration in conventional physical water treatment methods, and may adversely affect water used in household and commercial food preparation. Certain fruit crops are sensitive to elevated chloride levels in irrigation water supplies. A number of industries such as textiles, paper, and rubber may require chloride levels to be under 100 mg/L.

COLOUR

Two measures of colour are possible; true colour is a measure of the dissolved colouring compounds whereas apparent colour is influenced by the suspended material. The colour of a water is attributable to the presence of organic and inorganic materials; different materials absorb various light frequencies. Colour is measured according to the platinum-cobalt scale, which compares the colour of the water sample with that of a series of standard chemical solutions. Water with low turbidity exhibits virtually identical values for apparent and true colour. Water with turbidity greater than 3 JTU usually has a yellow, red, or brown tinge.

Environmental Range

Water whose colour is less than 10 platinum-cobalt (Pt-Co) units passes unnoticed to visual inspection; water with a value of 100 resembles black tea and may be encountered in waters draining peat deposits. Water from swamps and bogs may exhibit values in the 200 to 300 Pt-Co unit range.

Sources

A water's colour may be derived from a natural mineral or organic source. Humus and tannins, iron and manganese compounds, algae, protozoa, and decaying vegetation such as peat, all affect the colour of a water.

Organic and inorganic compounds from industrial or agricultural uses may add colour to a water. For example, steel works, refineries, chemical plants, pulp and paper plants, and a number of other industries may alter the colour of their discharge waters. Colouration may also result from irrigation.

Water Quality Guidelines

Colour is not normally considered a serious pollution problem, although colour may be detrimental in that it interferes with the passage of light, thereby impeding the photosynthesis of aquatic plants. Guidelines suggest that no undue increase in the colour of natural waters be allowed through waste disposal or other activities (Dep. of the Environ., 1972).

Domestic, industrial, and recreation uses of a water may be affected by the colour of a water. For aesthetic considerations and to prevent possible staining of clothes, food, and fixtures, the maximum acceptable limit for true colour in public drinking waters is 15 Pt-Co units (Dep. of Nat. Health & Welfare, 1969). For waters used for direct recreational contact such as swimming the maximum permissible colour is 100, although the objective is the same as the drinking water limit (Dep. of the Environ., 1972).

Effects on Use

Any perceptible colour in raw waters is objectionable from a purely aesthetic viewpoint. Although coloured water often has some absorptive and coagulative action which prevents scaling in industrial boilers, it is undesirable for many industrial processes. The production of fine papers, white textiles, and pharmaceuticals, as well as steam generation, may be impeded by a coloured water. Ice manufacture, beverage and photographic industries are affected by a coloured water supply. Domestic uses may also be adversely affected by the colour of a water.

COPPER

Copper is a common heavy metal constituent of

natural water. It is essential for all plant and animal nutrition. The divalent chemical form of copper salts, such as chloride, sulphate, and nitrate are highly soluble in water, whereas the carbonates, hydroxides, oxides, and sulphides are not. As a result, when copper ions are introduced into alkaline natural waters, they will precipitate as a hydroxide or basic copper carbonate and be removed by adsorption or sedimentation.

Environmental Range

Copper is generally present only in trace amounts in natural surface waters up to concentrations of 0.05 mg/L. It has been found that groundwaters may accumulate 12 mg/L. Seawater content ranges from 0.001 to 0.025 mg/L of copper. Generally, higher concentrations are a result of anthropogenic sources.

Sources

Natural sources of copper include the weathering of sulphide and carbonate ores under oxidizing conditions and from deposits of native copper. However, little copper in water is of natural origin because most copper minerals are relatively insoluble.

Human input of copper to waters may be significant. Contact with brass and copper plumbing and equipment is but one small source. Since copper has a wide industrial usage in textiles, anti-fouling paints, and in the manufacture of electrical products and utensils, industrial inputs may prove to be substantial. Smelters may contribute copper to the atmosphere which eventually is returned to surface waters. Acid mine waters frequently exhibit elevated copper concentrations. Agriculture uses require copper in the treatment of soils as a fungicide and a pesticide. Copper salts are added to water to control the growth of algae in reservoirs.

Water Quality Guidelines

Copper is essential to plants, animals, and man. An adult's daily ingestion requirement is 2.0 mg, a deficiency of copper may cause nutritional anaemia in infants. Excess copper is naturally excreted by the body.

Progressively increasing quantities of copper make water distasteful to drink. The threshold for taste perception varies from 1 to 5 mg/L. Very large doses produce emesis and prolonged ingestion may result in liver damage. Drinking waters should not contain more

than 1.0 mg/L, with optimal concentrations at 0.1 mg/L (Dep. of Nat. Health & Welfare, 1969).

Toxicity to aquatic organisms varies with the chemical speciation of copper as well as a number of physical and chemical characteristics of the water, such as its temperature, hardness, and turbidity. For the protection of aquatic freshwater species a maximum acceptable concentration of 0.05 mg/L of copper in water has been proposed (Gt. Lakes Wat. Qual. Bd., 1976a). Objectives for marine and estuarine waters have been set at a somewhat lower concentration of 0.01 mg/L (Environ. Stud. Bd., 1973).

Livestock can tolerate levels from 0.5 to 2.0 mg/L of copper in their waters, although the lower limit is more desirable as an objective (Environ. Stud. Bd., 1973).

To limit toxic reactions of plants copper concentrations in irrigation waters should be less than 0.2 mg/L for continuous use on all soil types.

Effects on Use

High concentrations of copper restrict the use of a water as a source of drinking water. Deposits of copper, copper oxides, and carbonates may occur on boiler walls. Copper may accelerate corrosion of iron, aluminum, and galvanized piping.

FLUORIDE

Fluoride is one of the halide group, which also includes chloride. Although it can be found in moderate quantities in the earth's crust, its presence in water is restricted by its low solubility. Fluorides are beneficial for dental hygiene.

Environmental Range

Surface water concentrations may be in excess of 50mg/L but typical concentrations are less than 1 mg/L; many natural freshwater streams actually have quantities less than 0.2 mg/L. Groundwaters usually possess higher concentrations than surface waters, often as high as 10 mg/L. During the dry season when groundwater input in a river is proportionally greater, fluoride concentrations may be somewhat greater. In seawater, fluoride concentrations are typically 1.2 mg/L.

Fluoride concentrations in brines have been recorded at 1 600 mg/L.

Sources

Alkaline and silicic igneous rocks supply a large portion of the fluorides to waters. Volcanic emanations, and water contact with fluorspar and shales are other natural sources of fluorides. Rain may contain fluoride concentrations from 0.001 to 1.0 mg/L.

Fluorides are used in a variety of industries, such as the processes of plating, aluminum, brick, and steel manufacture. Fluoride is released from the burning of coal in thermo-electric generating stations, however, unless an industrial spillage occurs, large quantities are seldom discharged into the environment. Insecticides and herbicides containing fluorides may be input by agricultural runoff. Sewage effluents from municipalities using fluoridated drinking water may discharge fluorides into waters.

Water Quality Guidelines

Small quantities of fluorides have proven beneficial in reducing tooth decay, however, excess concentrations have resulted in staining of tooth enamel. Single doses in excess of 250 mg/L have been shown to be toxic to man. Criteria for drinking waters have been formulated on the most sensitive water consumer, children, and related to quantity consumed. The objective set has been 1.2 mg/L of fluoride in all regions of Canada except the arctic or sub-arctic zones, where concentrations of 1.4 mg/L have been allowed (Dep. of Nat. Health & Welfare, 1969).

Livestock drinking water should not exceed 2 mg/L, since excess concentrations affect animal breeding efficiency and mottle the teeth of young animals.

To protect plants from detrimental effects, a limit of 1.0 mg/L has been proposed for acidic soils and 15 mg/L for neutral or alkaline soils which can inactivate fluorides (Environ. Stud. Bd., 1973).

Effects on Use

Rapid fluctuations of natural fluorides in water can create minor difficulties for water treatment plants in maintaining uniform concentrations when they fluoridate public drinking water.

HARDNESS

Hardness is principally determined by the sum of calcium and magnesium. The presence of other constituents, such as iron, manganese, and aluminum, may contribute to total hardness, though these are not usually present in appreciable concentrations. Water hardness relates to a water's capability to produce lather from soap. The harder the water, the more difficult it is to lather soap. Hardness is normally expressed as an equivalent of calcium carbonate (CaCO_3).

Environmental Range

The range of hardness can be outlined as follows:

Hardness as Calcium Carbonate (mg/L)	Degree of Hardness
0 — 30	Very soft
31 — 60	Soft
61 — 120	Moderately soft
121 — 180	Hard
>180	Very hard

Sources

The hardness of water varies greatly according to local conditions with areas of carbonate bedrock characteristically exhibiting hard water, whereas waters draining igneous rocks are very soft.

Water Quality Guidelines

An inverse statistical correlation between a water's hardness and certain heart diseases has been shown (Tai, 1970). The degree of hardness of a water may have a detrimental economic impact: water with a hardness less than 120 mg/L calcium carbonate can be deemed desirable for most uses, but only if hardness exceeds 500 mg/L can the water be labelled undesirable for both industrial and domestic uses.

Effects on Use

Hard water results in the formation of scale on boilers and pipes and it adversely affects textiles, plating, and canning industries. Hard water results in increased soap consumption, which affects both domestic and industrial cleaning and laundering activities.

IRON

Iron, which is found in both the ferrous (Fe^{2+}) and ferric (Fe^{3+}) state, is the fourth most abundant element in the earth's crust. Under reducing conditions in water, the mobile ferrous ion is present but upon exposure to air, it is oxidized to the less mobile form and precipitated as the ferric ion. In water, such iron precipitates produce reddish brown stains on porcelain, enamel, plumbing, and clothing. The solubility of iron increases with decreasing pH.

Environmental Range

Concentrations of iron in aerated surface waters are usually less than 0.5 mg/L but can be substantially greater in groundwaters and in thermal hot springs, where concentrations may range from 10 to 100 mg/L. Iron in seawater is usually 0.01 mg/L.

Sources

Iron is derived naturally from crustal weathering, especially from the minerals of igneous rocks and sulphide ores but also from sedimentary and metamorphic rocks. Iron oxides and iron hydroxides may be leached from sandstones. Atmospheric transport may provide as much as 0.05 mg/L of this element in rainfall.

Industrial wastes, the burning of coke and coal, acid mine drainage, mineral processing, and the corrosion of iron and steel may input iron into the environment.

Water Quality Guidelines

Few adverse effects are attributable to the presence of iron. In water, iron can discolour clothes, plumbing fixtures, and cause scaling which encrusts pipes. Excessive concentrations may promote bacterial activity in pipes and service mains. To minimize such adverse effects, an objective level of 0.3 mg/L has been proposed (Dep. of Nat. Health & Welfare, 1969).

Iron is highly objectionable for drinking water because of its bitter-sweet astringent taste. Drinking water concentrations of 0.3 mg/L have been deemed acceptable but concentrations less than 0.05 mg/L are more palatable.

When sufficient iron is added to water in the form of salts it may be precipitated from water upon contact with

air and may produce adverse effects on aquatic organisms, therefore, a criterion level of 0.3 mg/L total iron has been proposed for the protection of the aquatic environment (Gt. Lakes Wat. Qual. Bd., 1976a).

Although iron is a minor plant nutrient, toxicity has been recorded at concentrations in excess of 20 mg/L (Torrey, 1976). High iron concentrations may cause the fixation of essential elements required by plants and thus be detrimental. To avoid such effects irrigation waters on neutral or alkaline soils should not exceed 20 mg/L and should not exceed 5 mg/L on acid soils (Environ. Stud. Bd., 1973).

Effects on Use

The use of a water for domestic and drinking purposes is restricted by elevated iron concentrations. Iron staining interferes with cleaning and laundering activities and discolours dyes and textiles. Industrial requirements frequently require that the iron content of waters not exceed 0.2 mg/L but this is variable according to individual users.

LEAD

Lead is ubiquitous in the natural environment and may be found in both soluble and suspended forms in water. Generally low concentrations of lead are found in water owing to its low solubility. Lead at concentrations greater than 1 mg/L does not remain in solution but is precipitated. The concentration of lead and its relative toxicity is dependent on the hardness, pH, alkalinity, and dissolved oxygen content of a water. Lead is strongly absorbed by soils and is thus rendered unavailable to most plants.

Environmental Range

Natural waters seldom contain high lead concentrations. Waters draining regions of sulphide ores which contain lead may exhibit concentrations of 0.4 to 0.8 mg/L, however, most other natural waters typically contain only a trace to 0.04 mg/L. The solubility of lead in soft water is 0.5 mg/L while in hard water it is only 0.0003 mg/L. Ocean waters typically contain only 0.0003 mg/L.

Sources

The principal natural source of lead is the weathering of the sulphide ores, especially galena, but calcareous bedrock also contributes lead to the environment. It is possible for lead to be methylated in bottom sediments of rivers and lakes.

Man's input of lead to the environment clearly outweighs all natural sources. For example, anthropogenic lead input to the oceans is about ten times greater than that produced by natural weathering. The burning of leaded fuels, particularly automobile fuel, is of increasing concern. Other sources for lead include ore smelting and refining, production of storage batteries, lead pipes, and recycling lead products and motor oils. Lead salts are used in industry; lead acetates are used in printing and dyeing operations, while lead nitrates are used in photography, engraving, and in the manufacture of explosives. Lead chlorides and sulphates have been used in paint manufacture.

Water Quality Guidelines

Lead is a toxic material which accumulates in the skeletal structure of man and animals. Since human absorption of ingested lead is very small, single large doses of lead do not cause a problem. The sensitivity to lead toxicity varies according to individuals; young children are most vulnerable. The average food intake contains a substantial lead content, so drinking water concentrations have been formulated to avoid exceeding long-term accumulations of lead. Problems of high lead intake are man-induced and are not of a geochemical nature. The maximum concentration of lead in public drinking waters has been set at 0.05 mg/L (Dep. of Nat. Health & Welfare, 1969).

The toxicity of lead to fish decreases with increasing hardness and dissolved oxygen. Lead induces a coagulation film on the mucous membrane, which leads to eventual suffocation. Generally aquatic criteria are more stringent than those for drinking waters. To protect freshwater aquatic life a limit of 0.03 mg/L has been proposed (Environ. Stud. Bd., 1973). However, more specific criteria have been set for particular water bodies relating to water hardness and thus the proposed total lead concentrations in unfiltered water samples for the Great Lakes are: 0.01 mg/L for Lake Superior (soft); 0.02 mg/L for Lake Huron; and 0.025 mg/L for all other Great Lakes (hard) (Gt. Lakes Wat. Qual. Bd., 1976a). The acceptable level for the protection of marine

life has been set at 0.05 mg/L, with an objective limit of 0.01 mg/L for lead concentration.

To protect livestock from adverse effects resulting from the accumulation of lead in their bodies a limit of 0.1 mg/L has been proposed for livestock drinking waters (Environ. Stud. Bd., 1973; Agric. Canada).

Compared with other trace elements, the toxicity of lead to plants is relatively low. In addition, soils have a capacity of reducing the availability of lead to plants. The proposed levels of irrigation waters have been set at 10 mg/L for neutral and alkaline soils and 5 mg/L for acidic soils (Environ. Stud. Bd., 1973).

Effects on Use

Other than limiting the use of some waters as sources for public drinking supplies, there are few direct effects on use.

MAGNESIUM

Magnesium, an alkaline-earth metal, is an abundant element and a common constituent of natural waters. It is one of two main components that make up total hardness, the other being calcium. Magnesium salts are highly soluble and magnesium tends to remain in solution after the calcium salts have been precipitated.

Environmental Range

Magnesium concentrations in water are highly variable ranging from 1-2 mg/L to 100 mg/L, especially when proximal to its natural sources. High concentrations (1 000 mg/L) may be found in ocean waters, and brines may contain up to 57 000 mg/L of magnesium.

Sources

Natural sources clearly outweigh all cultural inputs of this constituent to the natural environment. Ferromagnesian minerals in igneous rocks and dolomitic sedimentary rocks are the principal contributors of magnesium to water.

In some cases, magnesium in industrial waste waters

may be appreciable. Some of the industries using magnesium include the manufacture of chemicals, imitation leathers, cements, tanning solutions, textiles, and explosives.

Water Quality Guidelines

Magnesium is non-toxic and poses a concern neither to public health nor to aquatic life. The presence of magnesium is beneficial for the heart and nervous systems, however, taste considerations are also important. Based on palatability, a maximum concentration of 150 mg/L has been established (Dep. of Nat. Health & Welfare, 1969). Concentrations greater than 50 mg/L induce mild laxative effects on people unaccustomed to that water source.

Effects on Use

Elevated magnesium concentrations may limit the use of water as a source of drinking water or irrigation water. Constraints on usability are elaborated in the section on hardness. An important concern is the precipitation of magnesium salts, which form a scale on the heating equipment.

MANGANESE

Manganese, a metallic cation, is similar to iron in its chemical behaviour and is frequently found in association with iron. It may exist in the manganous (Mn^{2+}) form but it is readily oxidized to the manganic (Mn^{4+}) form. Manganese is precipitated from solution by an oxidizing environment and by certain microorganisms. Nitrate, sulphate, and chloride salts of manganese are quite soluble in water, while oxides, carbonates, and hydroxides are only sparingly so.

Environmental Range

Manganese is not usually present in appreciable concentrations in surface waters. It seldom reaches concentrations of 1.0 mg/L in natural surface waters and is usually present in quantities of 0.2 mg/L or less. Higher levels may occur in groundwaters and deep stratified lakes and reservoirs under reducing conditions.

Sub-surface and acid-mine waters may contain 10 mg/L and some reservoirs may exhibit levels of 150 mg/L. Seawater has been found to contain 0.002 mg/L of manganese.

Sources

Soils and sediments are important sources of manganese along with metamorphic and sedimentary rocks. Ferromagnesian minerals, such as biotite mica and amphibole, contain large amounts of manganese. After plants die, the manganese which accumulates within them is available for re-solution in runoff and in soil moisture.

Manganese is a commonly used metal in industry; industrial wastes and acid-mine drainage may contribute manganese to waters. Iron and steel plants may release manganese into the atmosphere which is then redistributed through atmospheric deposition. In areas where soils exhibit manganese deficiency, agricultural uses may require the addition of manganese.

Water Quality Guidelines

Manganese is an essential element for nutrition of both humans and animals. A manganese deficiency may inhibit growth, disrupt the nervous system, and interfere with reproductive functions. It is an essential element for plant metabolism.

Guideline levels for this substance have been established, not on specific toxic effects, but rather on aesthetic and economic considerations. Since concentrations of manganese in waters in excess of 0.2 mg/L may be distasteful to drink, an objective of 0.05 mg/L has been set for drinking water (Dep. of Nat. Health & Welfare, 1969). An objective of 0.01 mg/L has been recommended to minimize dark brown or black stains on fabrics and porcelain (Dep. of Nat. Health & Welfare, 1969). It is improbable that any waters used by livestock for drinking may be at toxic levels and no limits have been suggested.

Irrigation waters for use on acid soils should not exceed 0.2 mg/L of manganese, while waters containing 10 mg/L may be used on neutral or alkaline soils (Environ. Stud. Bd., 1973).

The concentrations for the protection of the aquatic environment vary, but levels below 0.05 mg/L have been recommended for the protection of aquatic life (Environ. Stud. Bd., 1973).

Effects on Use

The presence of substantial amounts of manganese is objectionable in laundry and textile processing because of its staining qualities. Deposits on cooking utensils and in plumbing and pipes are associated with concentrations above 0.05 mg/L.

NITROGEN

Seventy-eight per cent by volume of the atmosphere is nitrogen. Igneous and sedimentary rocks also contain some nitrogen. Nitrogen and its compounds are ubiquitous in the biosphere. Nitrogen compounds are present in most plant and animal materials and thus in decaying organic matter.

There are a number of important chemical forms in which nitrogen may occur. The atmosphere provides a reservoir of inorganic nitrogen in the inert gaseous form

(N_2), but it is the combined forms of nitrogen that are of interest in the chemical composition of water. The process of nitrogen fixation involves a number of plant-bacteria symbioses but in the aqueous environment, chiefly bacteria and blue-green algae, reduce elemental nitrogen (N_2) to ammonia (NH_3) or ammonium ions (NH_4^+). Other groups of nitrifying bacteria can oxidize ammonia. One group of nitrifying bacteria converts ammonia to nitrite (NO_2^-); a second group of bacteria converts nitrite to nitrate (NO_3^-). In the process of denitrification bacteria convert nitrate to nitrite and then to the elemental nitrogen (N_2) form. Nitrogen fixation and the nitrification and denitrification processes of the nitrogen cycle are illustrated in Figure 2.

The concentrations of the various nitrogen compounds range up to 100 mg/L in surface waters, but groundwaters can contain up to 1000 mg/L.

The main aqueous forms of nitrogen with a chemical description, sources, and water quality guidelines are discussed individually in the following text.

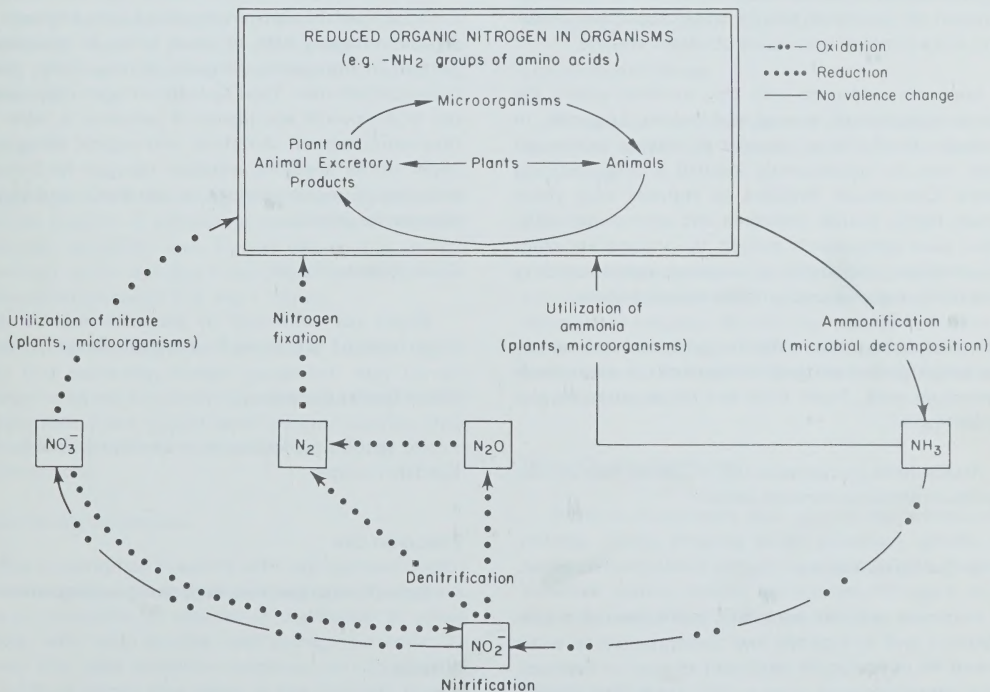


Figure 2. Nitrogen cycle. Source: Torrey, 1976, p. 120.

Ammonia

Ammonia is the most reduced inorganic form of nitrogen in water and includes dissolved ammonia (NH_3) and the ammonium ion (NH_4^+). Nitrogen-fixing bacteria living in a symbiotic association with plants or in soil or water reduce N_2 to ammonia and the ammonium ion.

Ammonia and its salts are very soluble in water; generally the ammonium ion is a transitory form. Although ammonia is only a small component of the total nitrogen cycle, ammonia contributes to the fertility of a water, since nitrogen is an essential plant nutrient.

Environmental Range

Natural waters typically contain concentrations of less than 0.1 mg/L. Levels greater than 0.1 mg/L may be indicative of anthropogenic inputs.

Sources

Since ammonia is a highly soluble compound resulting from either the decomposition of nitrogenous organic matter (vegetable or animal wastes) or the microbial reduction of nitrates or nitrites under anaerobic conditions, it is a common constituent of treated sewage.

Ammonia associated with clay minerals enters the aquatic environment through soil erosion. Legumes, in particular, can fix large amounts of nitrogen in the soil which may be subsequently leached into surrounding waters. Commercial fertilizers to improve crop yields contain highly soluble ammonia and ammonium salts. When such compounds exceed the immediate plant requirements, precipitation or irrigation waters can carry these nitrogen compounds into the aquatic system.

Ammonia may also be discharged from a wide variety of industrial and cleaning operations that use ammonia or ammonium salts. Paper mills and metal refineries also use ammonia.

Atmospheric precipitation and dry fallout may contain significant ammonia concentrations.

Water Quality Guidelines

Ammonia is a non-persistent, non-cumulative toxic substance and its typically low concentrations in water present no physiological detriment to man or livestock. Since ammonia may taint water (taste and odour), drinking waters should not exceed 0.1 mg/L (Dep. of Nat. Health & Welfare, 1969).

Fish cannot tolerate large quantities of ammonia since it reduces the oxygen carrying capacity of the blood and thus the fish may suffocate. Ammonia toxicity is related to the amount of dissociated ammonium and is dependent upon both pH and dissolved oxygen. For the protection of freshwater aquatic life a level of 0.02 mg/L should not be exceeded (Environ. Stud. Bd., 1973). Under the more alkaline conditions in the marine environment, ammonia may be more toxic and a level of 0.4 mg/L may be hazardous with 0.01 mg/L required for minimal risk (Environ. Stud. Bd., 1973).

Effects on Use

Ammonium salts are destructive to concrete. Since ammonia is sometimes corrosive to copper and its alloys, ammonia may corrode water distribution lines. Ammonia's interaction with chlorine may affect the disinfection efficiency in a water, thus increasing chlorine demands in water treatment plants. Ammonia may also promote the growth of the aquatic biota.

Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen measures both ammonia and organic nitrogen. Both of these forms of nitrogen are present in nitrogenous organic detritus from natural biological activities. Total Kjeldahl nitrogen may contribute to the overall abundance of nutrients in water and thus eutrophication. Ammonia and organic nitrogen are important for assessing available nitrogen for biological activities. Consult sections on ammonia and organic nitrogen for details.

Environmental Range

Rivers not influenced by excessive organic inputs range from 0.1 to 0.5 mg/L Kjeldahl nitrogen.

Water Quality Guidelines

No specific guidelines have been proposed for total Kjeldahl nitrogen.

Effects on Use

Consult individual species of nitrogen compounds.

Nitrate

Nitrate (NO_3^-) is the principal form of combined nitrogen found in natural waters. The highly soluble

nitrate ion, which is the most stable form of combined nitrogen in surface waters, results from the complete oxidation of nitrogen compounds. Nitrification (conversion of ammonia or nitrite to nitrate) is the principal process in the nitrogen cycle.

Most surface waters contain some nitrates, however, the presence of nitrates greater than 5 mg/L may reflect unsanitary conditions, since one major source of nitrates is human and animal wastes. Plants are capable of converting nitrates to organic nitrogen. Since nitrates stimulate plant growth, aquatic organisms (such as algae) flourish in the presence of nitrates and excessive amounts of nitrate may result in prolific growth.

Environmental Range

Although surface waters may contain more than 100 mg/L, they rarely contain as much as 5 mg/L and often less than 1 mg/L of nitrate. The nitrate concentrations in groundwaters range up to 1 000 mg/L. In areas where inorganic nitrogen fertilizers are used groundwaters may contain 100 mg/L.

Nitrate concentrations in surface waters may fluctuate, being somewhat higher in winter months when groundwater input is proportionally greater and in the spring when contributions from overland runoff are substantial.

Sources

Igneous rocks and volcanic emanations provide minor localized sources of nitrates to water. Upon complete oxidation vegetable and animal debris and animal excrement can be significant sources of nitrates in water. Rainwater may contain 0.2 mg/L nitrate.

Industrial discharges and municipal sewage, especially that containing human excrement, may contain nitrates. Inorganic nitrate fertilizers are used in agriculture to stimulate plant growth and waters draining from agricultural lands may possess substantial nitrate concentrations.

Water Quality Guidelines

The consumption of waters with high nitrate concentrations decreases the oxygen-carrying capacity of blood. This is particularly of concern in the health of young infants, who may develop methaemoglobinaemia. To protect this most sensitive consumer, an objective of 10 mg/L of nitrate plus nitrite (a less oxidized form of nitrogen) has been established for drinking waters (Dep. of Nat. Health & Welfare, 1969).

Similar to man livestock are subject to adverse effects when waters consumed by them contain nitrates. The concentration of nitrate producing deleterious effects varies with the type of animal. An objective with a reasonable margin of safety for livestock water supplies of less than 100 mg/L of nitrate has been established (Environ. Stud. Bd., 1973; Agri. Canada).

Effects on Use

Nitrate concentrations affect the use of a water for drinking. Nitrates may prove troublesome for the textile industry in the dyeing of wools and silks and may also affect the brewing industry's fermentation process.

Nitrite

Nitrite is a chemical form of nitrogen that is typically found in minute quantities in surface waters. Since nitrite is unstable in the presence of oxygen, it occurs as an intermediate form between ammonia and nitrates (nitrification) or nitrates and nitrogen gas (denitrification). The nitrite ion can be used as a nitrogen source by plants. The presence of nitrites in water indicates active biological processes influenced by organic pollution.

Environmental Range

Nitrites are normally absent or present only in minute quantities in surface waters, usually in the order of 0.001 mg/L.

Sources

Nitrites may be discharged from industries or municipal sewage plants. Nitrite salts are used as corrosion inhibitors in industry. Nitrites may also be formed in the rumens of animals and freshly cropped forage or moist feeds, since they are an intermediate oxidation product of organic nitrogen.

Water Quality Guidelines

Nitrite is much more toxic to man and animals than nitrates. Public drinking water guidelines specify that nitrite concentrations should not exceed 1 mg/L, whereas livestock waters should not exceed 10 mg/L nitrite (Environ. Stud. Bd., 1973; Agri. Canada).

Effects on Use

Consult the section on nitrates.

Organic Nitrogen

Organic nitrogen is an organically bound form of nitrogen that is the most reduced form (-3 oxidation state). It is also referred to as amino- or albuminoid forms of nitrogen. Organic nitrogen includes all organic compounds, such as proteins, polypeptides, and amino acids.

Environmental Range

Organic nitrogen in surface and groundwaters is very low, typically less than 0.01 mg/L.

Sources

Organic nitrogen results from both the inflow of nitrogenous debris from a watershed and from the normal biological activities in a stream. Anthropogenic sources include sewage effluents, farm runoff, and nitrogenous aerosols. Industrial wastes such as those discharged from slaughterhouses and chemical plants may contain organic nitrogen.

Water Quality Guidelines

Organic nitrogen *per se* is not of concern to human health and no guidelines for drinking waters or for the protection of aquatic life have been proposed.

Effects on Use

No direct effects, but consult sections on ammonia and nitrite.

reduce the dissolved oxygen levels to concentrations approaching zero.

Environmental Range

Typically the concentration of dissolved oxygen in natural surface waters is less than 10 mg/L. The solubility of atmospheric oxygen (i.e. saturation) in freshwater ranges from approximately 15 mg/L at 0°C to 8 mg/L at 25°C at sea level. Seawater saturation ranges from 11 mg/L at 0°C to 7 mg/L at 25°C.

Sources

The oxygen dissolved in waters may be derived from either the atmosphere or from photosynthesis by aquatic plants.

Water Quality Guidelines

Dissolved oxygen concentrations produce no adverse physiological effect on man, however, adequate amounts of dissolved oxygen must be available for fish and other aquatic organisms.

Many aerobic organisms cannot survive below certain levels of dissolved oxygen. The dissolved oxygen requirement is dependent on temperature and varies greatly from organism to organism, therefore, the recommendation of a single arbitrary oxygen concentration for all organisms in all types of waters is not very useful. Fluctuations in the concentration of dissolved oxygen to extremely low concentrations are particularly harmful to the organisms in an aquatic environment. Although minimum acceptable values of dissolved oxygen are not appropriate, it has been shown that concentrations of less than 4 mg/L produce detrimental effects on most aquatic organisms (Dep. of the Environ., 1972).

Several different guidelines have been suggested for various levels of protection of fisheries. The selection of a guideline level is based on socioeconomic rather than biological criteria.

Figure 3 shows four levels of protection for fish based on the amount of dissolved oxygen. Each of these four curves depicts the relationship between the estimated natural dissolved oxygen concentration minimum and its corresponding seasonal minimum for fishery protection based on a selected protection level. Level I offers a high level of protection and depicts no depression of dissolved oxygen levels below natural minimum levels. Level II has a minimal depletion of dissolved oxygen unlikely to cause reduction in fish production. Level III offers moderate

OXYGEN

Dissolved Oxygen

Oxygen is one of the gases that is found dissolved in natural surface waters. It is moderately soluble in water. The amount of dissolved oxygen in natural waters is quite variable and is dependent on temperature, salinity, turbulence (mixing) of the water, and atmospheric pressure (decreasing with altitude). The concentration of dissolved oxygen is subject to diurnal and seasonal fluctuations which are due, in part, to variations in temperature, photosynthetic activity and river discharge. Biodepletion and re-aeration processes control the dissolved oxygen concentrations. The decomposition of organic wastes and oxidation of inorganic wastes may

protection to fisheries, especially appropriate to those coexisting with populated industrial regions. Level IV only provides a low level of protection to fish where fisheries are not a prime consideration (Dep. of the Environ., 1972).

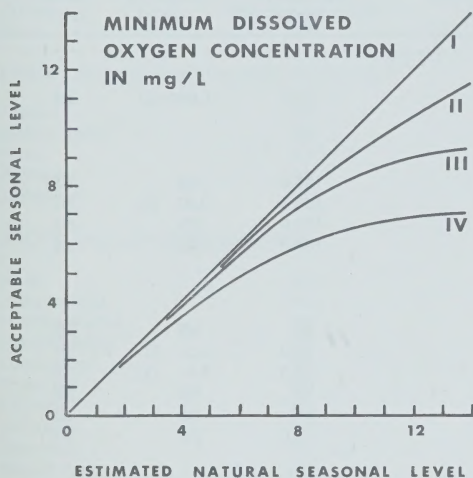


Figure 3. Proposed dissolved oxygen criteria for the protection of freshwater fisheries. Source: Environment Canada, Tech. Bull. No. 67, 1972.

Drinking water criteria do not specify any guidelines for dissolved oxygen, although waters saturated with dissolved oxygen are preferable for drinking as improved palatability results from dissolved oxygen's ability to precipitate substances such as iron and manganese which produce undesirable tastes.

Effects on Use

Waters highly saturated with dissolved oxygen are acceptable for all uses except for industrial applications, since the presence of dissolved oxygen increases the corrosiveness of a water. Thus the absence of dissolved oxygen is preferable for many industrial applications.

PESTICIDES

Pesticides are chemical compounds (organic or inorganic) used to control noxious "pests" which attack crops, animals, and man. Such "pests" may be insects,

weeds, or fungi, hence the term pesticide includes insecticides, herbicides, fungicides. Pesticides are formulated to control "pests", whereas the more general term biocide is applied to any substances capable of killing living organisms (e.g. PCBs, cyanide).

Pesticides have both beneficial and detrimental characteristics and may be regarded as environmental contaminants if they extend beyond the area of intentional application or persist longer than is necessary to control the pest. A major concern with pesticides is their accumulation in the environment and, in particular, their biological magnification in the food web.

Pesticides may reach the aquatic environment in a number of ways: i) drift from aerial spraying; ii) surface runoff; iii) percolation and subsurface runoff from treated lands; iv) careless application or spillage; v) direct aquatic application to control undesirable aquatic organisms; and vi) sewage discharge and industrial effluents. Pesticides may also be subject to atmospheric transport and redeposition.

Pesticides may be sub-divided into chemical families of compounds sharing common characteristics. One main division may be made according to whether the compound is organic or inorganic; organic compounds contain linked carbon atoms in their chemical structure. Table A lists the pesticides on NAQUADAT, according to their chemical family, along with their water quality guidelines. Table B is an alphabetic tabulation of these pesticides with both their chemical name and empirical formula.

Organochlorine compounds, also known as chlorinated hydrocarbons contain chlorine, carbon, and hydrogen in their structure. They are, environmentally, the most important group of synthetic organic insecticides because of their widespread use, great stability, and toxicity. Their toxicity is related to the disruption of oxygen uptake, which leads to suffocation and death. This effect applies equally well to aquatic and terrestrial organisms. Another potentially hazardous aspect of chlorinated hydrocarbons is that they tend to accumulate in fatty tissues of animals, including man.

Although organophosphorus compounds are derivatives of phosphoric acid and the carbamates are derived from carbamic acid, both classes have similar toxicological effects. Their toxicity is dependent on their ability to deactivate cholinesterase in the body, thereby permitting uninterrupted impulses to flow along the nervous system, which eventually results in death.

TABLE A: PESTICIDES (ON NAQUADAT) GROUPED INTO CHEMICAL FAMILIES WITH THEIR WATER QUALITY GUIDELINES

Common Name*	Water Quality Guidelines				
	Raw Water Supply (1)		Livestock Watering (2) (µg/L)	Protection of Aquatic Life	
	Objective/Acceptable (µg/L)	Maximum Permissible (µg/L)		Freshwater (µg/L)	Marine (µg/L)
GROUP: Botanical Compounds					
Allethrin	ND †	100.0	NS‡	0.002 (2)	NS
GROUP: Carbamate Compounds					
Barban	ND	100.0	100.0	NS	NS
Carbaryl	ND	100.0	100.0	0.02 (2)	NS
Carbofuran	ND	100.0	100.0	NS	NS
Diallate	ND	100.0	100.0	NS	NS
GROUP: Chlorophenoxy Compounds					
MCPA	ND	100.0	NS	NS	NS
Silvex	ND	100.0	30.0	2.5 (2)	NS
2, 4-D	ND	100.0	20.0	4.0 (2)	NS
2, 4-DB	ND	100.0	NS	NS	NS
2, 4-DP	ND	100.0	NS	NS	NS
2, 4, 5-T	ND	100.0	2.0	NS	NS
GROUP: Cyclohexene, Phthalimide and Propionic Compounds					
Captan	ND	100.0	NS	NS	NS
Dalapon	ND	100.0	NS	110.0 (2)	NS
GROUP: Dinitrophenol Compounds					
Dichloran	ND	100.0	NS	NS	NS
Dinoseb	ND	100.0	NS	NS	NS
Trifluralin	ND	100.0	NS	NS	NS
GROUP: Miscellaneous Compounds					
Alachlor (amide)	ND	100.0	NS	NS	NS
Endaven (amide)	ND	100.0	NS	NS	NS
GROUP: Organochlorine Compounds					
Aldrin	ND	17.0	1.0	0.001 (3)	0.003 (4)
BHC	NS	NS	NS	NS	NS
Chlordane	ND	3.0	3.0	0.01 (4)	0.004 (4)
Cyclethrin	NS	NS	NS	NS	NS
DDD	NS	NS	NS	0.003 (3)	NS
DDE	NS	NS	NS	0.003 (3)	NS
DDT	ND	42.0	50.0	0.003 (3)	0.001 (4)
Dieldrin	ND	17.0	1.0	0.001 (3)	0.003 (4)
Endosulfan	NS	NS	NS	0.003 (4)	0.001 (4)
Endrin	ND	1.0	0.5	0.002 (3)	0.004 (4)
Heptachlor	ND	18.0	0.1	0.001 (3)	0.001 (4)
Heptachlor epoxide	ND	18.0	0.1	0.001 (3)	NS
Kelthane	NS	NS	NS	NS	NS

* NAQUADAT Designation

† Not Detectable

‡ Not Specified

(1) Dep. of Nat. Health & Welfare, 1969

(2) Environ. Stud. Bd., 1973

(3) Gt. Lakes Wat. Qual. Bd., 1976b

(4) U.S. Environ. Prot. Agency, 1976

(5) Gt. Lakes Wat. Qual. Bd., 1976a

TABLE A: PESTICIDES (ON NAQUADAT) GROUPED INTO CHEMICAL FAMILIES WITH THEIR WATER QUALITY GUIDELINES
(concluded)

Water Quality Guidelines					
Common Name	Raw Water Supply (1)		Livestock Watering (2) (µg/L)	Protection of Aquatic Life	
	Objective/Acceptable (µg/L)	Maximum Permissible (µg/L)		Freshwater (µg/L)	Marine (µg/L)
GROUP: Organochlorine Compounds (Continued)					
Lindane	ND	56.0	5.0	0.01 (4)	0.004 (4)
Methoxychlor	ND	35.0	1000.0	0.03 (4)	0.03 (4)
Mirex	NS	NS	NS	0.001 (4)	0.001 (4)
Perthane	NS	NS	NS	NS	NS
Toxaphene	ND	5.0	5.0	0.005 (4)	0.005 (4)
GROUP: Organophosphorus Compounds					
Abate	ND	100.0	100.0	NS	NS
Azinphosethyl	ND	100.0	100.0	NS	NS
Chlorfenvinphos	ND	100.0	100.0	NS	NS
Chlorpyrifos	ND	100.0	100.0	NS	NS
Coumaphos	ND	100.0	100.0	0.001 (2)	NS
Cruformate	ND	100.0	100.0	NS	NS
Diazinon	ND	100.0	100.0	0.08 (5)	NS
Dichlorvos	ND	100.0	100.0	0.001 (2)	NS
Dimethoate	ND	100.0	100.0	NS	NS
Disulphoton	ND	100.0	100.0	0.05 (2)	NS
Ethion	ND	100.0	100.0	0.02 (2)	NS
Fenitrothion	ND	100.0	100.0	NS	NS
Fensulfothion	ND	100.0	100.0	NS	NS
Fenthion	ND	100.0	100.0	0.006 (2)	NS
Guthion	ND	100.0	100.0	0.005 (5)	0.01 (4)
Leptophos	ND	100.0	100.0	NS	NS
Malathion	ND	100.0	100.0	0.1 (4)	0.1 (4)
Methyl Parathion	ND	100.0	100.0	NS	NS
Methyl Trithion	ND	100.0	100.0	NS	NS
Parathion	ND	100.0	100.0	0.008 (5)	0.04 (4)
Phorate	ND	100.0	100.0	NS	NS
Phosalone	ND	100.0	100.0	NS	NS
Phosdrin	ND	100.0	100.0	NS	NS
Phosmet	ND	100.0	100.0	NS	NS
Phosphamidon	ND	100.0	100.0	0.03 (2)	NS
Ronnel	ND	100.0	100.0	NS	NS
Trithion	ND	100.0	100.0	NS	NS
GROUP: Pyridylum Compounds					
Diquat	ND	100.0	NS	0.5 (2)	NS
Paraquat	ND	100.0	NS	NS	NS
GROUP: Triazine Compounds					
Atrazine	ND	100.0	NS	NS	NS
Cyanazine	ND	100.0	NS	NS	NS
Cyprazine	ND	100.0	NS	NS	NS
Metribuzin	ND	100.0	NS	NS	NS
Prometone	ND	100.0	NS	NS	NS
Simazine	ND	100.0	NS	10.0 (2)	NS
GROUP: Trichloroacetate, Trichlorobenzoic, and Trichloropicolinic Compounds					
Dicamba	ND	100.0	NS	NS	NS
Picloram	ND	100.0	NS	NS	NS
TCA	ND	100.0	NS	NS	NS

TABLE B: ALPHABETIC LISTING OF PESTICIDES (ON NAQUADAT) INCLUDING COMMON, SCIENTIFIC, AND BRAND NAMES

Common Name *	Empirical Chemical Formula	Chemical Name or Definition	Other Names	Solubility in Water	Primary Use
Abate	$C_{16}H_{20}O_6P_2S_3$	o,o,o',o'-tetramethyl o,o'-(thio-di-p-phenylene) di-phosphorothioate	Abathion, Biothion, Bithion, Nimitox temephos	NF†	Insecticide
Alachlor	$C_{14}H_{20}ClNO_2$	2-chloro-2', 6'-diethyl-N-(methoxymethyl) acetanilide	Alachlore, Lasso	140 mg/L	Herbicide
Aldrin	$C_{12}H_8Cl_6$	1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4-endo-exo-5, 8-dimethanonaphalene	Alarite, Aldrec, Aldrex, Aldrine, Aldrosol, Algran, compound 118, Drinox, HHDN, Octalene, Seedrin Liquid, Soildrin	27 µg/L	Insecticide
Allethrin	$C_{19}H_{26}O_3$	dl-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one ester of 1, 2-dimethyl-3-(2-methylpropenyl)-cyclopropane carboxylic acid	Alletrina, allyl cinerin, palléthrine, Pynamin	NF	Insecticide
Atrazine	$C_8H_{14}ClN_5$	2-chloro-4-ethylamino-6-isopropylamino-1, 3, 5-triazine	Aatrex, Atranex, Atrasol, atrazina, Gesaprim, Primatol, Vectal	33 mg/L	Herbicide
Azinphosethyl	$C_{12}H_{16}N_3O_3PS_2$	o, o-diethyl S-4-oxo-1, 2, 3-benzotriazin-3 (4H)-ylmethyl phosphorodithioate	azinphosetile, Azinos, Bay 16259, Cotnion-Ethyl, Ethyl Guthion, Gusation A, R1513, triazotion	insoluble	Insecticide
Barban	$C_{11}H_9Cl_2NO_2$	4-chloro-2-butylnyl N-(3-chlorophenyl) carbamate	barbamate, barbane, Carbyne, chlorinat, Oatax	insoluble	Herbicide
BHC	$C_6H_6Cl_6$	1, 2, 3, 4, 5, 6-hexachlorocyclohexane mixed isomers (cis/trans)	Agrocide, Ambicide, Benzahex, benzene hexachloride, DBH, Dol, Dolmix, FBHC, Gammacide, Gammaloid, Gammexane, Gamtox, Gemaspra, Gyben, HCCH, HCH, Hexachloran, Hexadow, Hexafor, Hexaklor, Hexyclan, Isotox, Kotol, Lintox Lexone, Soporocide, Trivex-T, 666	insoluble	Insecticide
Captan	$C_9H_8Cl_3NO_2S$	N-trichloromethylmercapto-4-cyclohexene-1, 2, dicarboximide	captane, captano, Merpan, Orthocide, Orthocide 406, Vondcaptan	insoluble	Fungicide
Carbaryl	$C_{12}H_{11}NO_2$	1-naphthyl methylcarbamate	Denapon, Dicarbam, Hexavin, Karbaspray, Nac, Ravyon, Septene, Sevin, Tricarnam, 7744	40 mg/L	Insecticide
Carbofuran	$C_{12}H_{15}NO_3$	2, 3-dihydro-2, 2-dimethyl-benzofuran-7-yl methylcarbamate	Bay 70142, Curaterr, D 1221, Ent 27164, FMC 10242, Furan, NIA 10242, Yaltox	700 mg/L	Insecticide Nematocide
Chlordane	$C_{10}H_6Cl_8$	1, 2, 4, 5, 6, 7, 8, 8-octachloro-3a, 4, 7, 7a-tetrahydro-4, 7-methanoindane (mixed isomers)	Aspon, Belt, Chlordan, Chlorogran, Chlor Kil, clordano, Corodane, Krypchor, Penicklor, Prentox, Octachlor, Octa-Klor, Synklor, Topiclor 20, Velsical 1068,	insoluble	Insecticide
Chlorfenvinphos	$C_{12}H_{14}Cl_3O_4P$	2-chloro-1-(2, 4-dichlorophenyl) vinyl diethyl phosphate (mixed isomers)	Birlane, C8949, Compound 4072, Sapecron, Supona, Vinylphate	NF	Insecticide

* NAQUADAT designation

† Not found

TABLE B: ALPHABETIC LISTING OF PESTICIDES (ON NAQUADAT) INCLUDING COMMON, SCIENTIFIC, AND BRAND NAMES
(continued)

Common Name	Empirical Chemical Formula	Chemical Name or Definition	Other Names	Solubility in Water	Primary Use
Chlorpyrifos	C ₉ H ₁₁ Cl ₃ NO ₃ PS	o, o-diethyl-o-(3, 5, 6-trichloro-2-pyridyl) phosphorothioate	Dowco-179, Dursban, Lorsban	NF	Insecticide
Coumaphos	C ₁₄ H ₁₆ ClO ₅ PS	o, o-diethyl o-3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl-phosphorothioate	Asunto, B-21/199, Baymix, Co-Ral, Meldane, Muscatox, Reistox, 7-Co-ral	insoluble	Insecticide
Crufomate	C ₁₂ H ₁₉ ClNO ₃ P	4-tert-butyl-2-chlorophenyl methyl, methyl-phosphoramidate	Dowco 132, Ruelene	NF	Insecticide
Cyanazine	C ₉ H ₁₃ ClN ₆	2-[(4-Chloro-6-ethylamino-s-triazin-2-yl) amino]-2-methyl-propionitrile	Baldex, Fortrol, Payze, SD 15418, WL 19805, DW 3418	NF	Herbicide
Cyathrin	C ₂₁ H ₂₈ O ₃	3-(2-cyclopenten-1-yl)-2-methyl-4-oxo-2-cyclopenten-1-yl chrysanthemumate		NF	Insecticide
Cyprazine	C ₉ H ₁₄ ClN ₅	2-chloro-4-cyclopropylamino-6-isopropylamino-s-triazine	Outfox, S-6115	insoluble	Herbicide
Dalapon	C ₃ H ₄ Cl ₂ O ₂	2-2-dichloropropionic acid	Basfapon, Dalacide, Dalapon-Na, Ded-Weed, Dowpon, Dowpon M, DPA, Gramevin, Radapon, Unipon	very soluble	Herbicide
DDD	C ₁₄ H ₁₀ Cl ₄	2, 2-bis(p-chlorophenyl)-1, 1-dichloroethane	Rhothane, TDE, ME 1700	NF	Insecticide
DDE	C ₁₄ H ₈ Cl ₄	1, 1-dichloro-2, 2-bis (p-chlorophenyl) ethylene	DDX	NF	Insecticide
DDT	C ₁₄ H ₉ Cl ₅	dichloro diphenyl trichloroethane	Anofex, Anofox, chlorophenothane, chloro-phenothene, Dedelco, dicophane, Didimac, Dinocide, Genitox, Gesapon, Gesarex, Gesarol, Guesarol, Gyron, Ixodex, Kopsol, Neocid, Neocide, Neocidol, pentachlorin, Rukseam, Zerdane		Insecticide
Di-allate	C ₁₀ H ₁₇ Cl ₂ NOS	5-(2, 3-dichloroallyl) di-isopropylthiocarbamate	Avadex, CP 15336, DATC, DDTC, 2, 3-DCDT	NF	Herbicide
Diazinon	C ₁₂ H ₂₁ N ₂ O ₃ PS	o, o-diethyl o-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	Alfa-tox, Basudin, Dazzel, Diazajet, Diazide, Diazitol, G24480, Gardentox, Neocidol, Nucidol, Saralex, Sarolex, Spectracide	40 mg/L	Insecticide Nematocide
Dicamba	C ₈ H ₆ Cl ₂ O ₃	2-methoxy-3, 6-dichlorobenzoic acid	Banex, Banvel, Banvel D, Compound B, dianat, Mediben, Velsicol, 58-C5-11	NF	Herbicide
Dichloran	C ₆ H ₄ Cl ₂ N ₂ O ₂	2, 6-dinitro-4-nitroaniline	Allisan, Botran, CDNA, DCNA, dicloran, Ditrail, Reisan	NF	Fungicide
Dichlorvos	C ₄ H ₇ Cl ₂ O ₄ P	2, 2-dichlorovinyl dimethyl phosphate	Cerusan, DDVP, Dedevap, Divipan, Herkol, Mafu, Marvex, Nerkol, No-Pest, Nogos, Nuvan, Oka, Oko, Phosvil, Vapona	10 000 mg/L	Insecticide

TABLE B: ALPHABETIC LISTING OF PESTICIDES (ON NAQUADAT) INCLUDING COMMON, SCIENTIFIC, AND BRAND NAMES
(continued)

Common Name	Empirical Chemical Formula	Chemical Name or Definition	Other Names	Solubility in Water	Primary Use
Dieldrin	C ₁₂ H ₈ Cl ₆ O	1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-1, 4-endo-exo-5, 8-dimethanonaphthalene	Alvit, Compound 497, Dieldrex, Dieldrite, HEOD, Octalox, Panoram D31	insoluble	Insecticide
Dimethoate	C ₅ H ₁₂ NO ₃ PS ₂	o, o-dimethyl S-(N-methylcarbamoyl methyl) phosphorodithioate	AC-12880, Cygon, Daphene, De-Fend, Demos L40, Dimethogen, dimoate, Ferkethion, fosfamid, fostion MM, Perfekthion, Rebelate, Rogor, Roxion, Trimetion	20 000 mg/L	Insecticide
Dinoseb	C ₁₀ H ₁₂ NO ₅	2-sec-butyl-4-6-dinitrophenol	Chemox, dimosebe, DNBP, DNOSBP, DNSBP, DN 289, Elgetol 318, Gebutox, Knox-Weed, Premerge, Sinox General, Supersevtox	soluble salts	Herbicide Insecticide Fungicide
Diquat	C ₁₂ H ₁₂ N ₂	9, 10-dihydro-8a, 10a-dizoniaphenanthrene ion	Aquacide, deiquat, Dextrone, FB/2, region, Reglone, Reglox, Weedtrine-D	completely soluble	Herbicide
Disulphoton	C ₈ H ₁₉ O ₂ PS ₃	o, o-diethyl S-[2-(ethylthio)-ethyl] phosphorodithioate	Bay 19639, Di-Syston, dithiodemeton, Dithiosystox, Ekatine, Frumin, thiodemeton, S276, Solvirex	insoluble	Insecticide Nematocide
Endaven	C ₁₈ H ₁₇ Cl ₂ O ₃ N	Ethyl N-benzoyl-N-(3, 4-dichlorophenyl)-2-aminopropionate	Enaven, SD 30053, Suffix, WL 17731	NF	Herbicide
Endosulfan	C ₉ H ₆ Cl ₆ O ₃ S	6, 7, 8, 9, 10, 10-Hexachloro-1, 5, 5a, 6, 9, 9a-hexahydro-6, 9-methano-2, 4, 3-benzodioxathiepin-3-oxide	benzoepin, Beosit, chlorthiepin, Cyclodan FMC 5462, Hoe 2671, Insectophene, Kopthiodan, Malix, NIA 5462, Thimul, Thiodan, Thioden, Thiofor, Thionex	insoluble	Insecticide
Endrin	C ₁₂ H ₈ Cl ₆ O	1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-1, 4-endo-endo-5, 8-dime-thanonaphthalene	Compound 269, Endrex, endrine, Hexadrin, Mendrin, nendrin	NF	Insecticide Rodenticide
Ethion	C ₉ H ₂₂ O ₄ P ₂ S ₄	o, o, o', o'-Tetraethyl S, S'-methylene bisphosphorodithioate	diéthion, NIA 1240, Nialate	slightly soluble	Insecticide
Fenitrothion	C ₉ H ₁₂ NO ₅ PS	o, o-Dimethyl o-(4 nitro-m-tolyl) phosphorothioate	Accothion, Agrothion, Bay 41831, Cytel, Dicofen, Fenstan, Folithion, MEP, Metathion E-50, methyl nitrophos, Novathion, Nuvanol, S 5660, Sumithion, Verthion	insoluble	Insecticide
Fensulfothion	C ₁₁ H ₁₇ O ₄ PS ₂	o, o-diethyl o-[p-(methylsulfinyl) phenyl] phosphorothioate	Bay 25141, Dasanit, DMSP, S 767, Terracur-P	1 600 mg/L	Insecticide Nematocide
Fenthion	C ₁₀ H ₁₅ O ₃ PS ₂	o, o-dimethyl o-[4-methylthio-m-tolyl] phosphorothioate	Bay 29493, Baycid, Baytex, Entex, Figuron, Lebaycid, Queletox, S 1752, Spotton, Tiguvon	55 mg/L	Insecticide
Guthion	C ₁₀ H ₁₂ N ₃ O ₃ PS ₂	o, o-dimethyl S(4 oxo-1, 2, 3-benzotriazin-3 (4H)-ylmethyl) phosphorodithioate	azinphos-méthyl, Azinphosmethyl, azintos metile, Bay 17147, Carfene, Cothion-methyl, Gusathion, Gusathion M, metiltria-zottion, R 1582	29 mg/L	Insecticide

TABLE B: ALPHABETIC LISTING OF PESTICIDES (ON NAQUADAT) INCLUDING COMMON, SCIENTIFIC, AND BRAND NAMES
(continued)

Common Name	Empirical Chemical Formula	Chemical Name or Definition	Other Names	Solubility in Water	Primary Use
Heptachlor	C ₁₀ H ₅ Cl ₇	1, 4, 5, 6, 7, 8, 8-heptachloro-3a, 4, 7, 7a-tetrahydro-4, 7-endo-methanoindene	Drinox, eptachloro, heptachlore, Heptagran, Heptalube, Velisicol 104	insoluble	Insecticide
Heptachlor epoxide	C ₁₀ H ₅ Cl ₇ O	1, 4, 5, 6, 7, 8, 8-heptachloro-2, 3-epoxy-3a, 4, 7, 7a-tetrahydro-4, 7-methanoindan		NF	Insecticide
Kelthane	C ₁₄ H ₉ Cl ₅ O	1, 1-bis(p-chlorophenyl)-2, 2, 2-trichloroethanol	Acarin, Dicofol, DTMC, FW-293, Mitigan	NF	Insecticide
Leptophos	C ₁₃ H ₁₀ BrClO ₂ P	o-(4-bromo-2, 5-dichlorophenyl) o-methyl phenylphosphonothioate	Abar, MBCP, Phosvel, VCS-506	30 µg/L	Insecticide
Lindane	C ₆ H ₆ Cl ₆	γ-1, 2, 3, 4, 5, 6-hexachlorocyclohexane	Forlin, Gamaphex, gamma-BHC, gamma-HCH, Gammalin, Gammexane, Gammopaz Gexane, Lindafor, Lindagram, Lindex, Lindust, Lintox, Kwell, Novigam, Silvanol	NF	Insecticide Rodenticide
Malathion	C ₁₀ H ₁₉ O ₆ PS ₂	o, o-diethyl S-(1, 2-dicarbethoxyethyl) dithiophosphate	carbofos, Chemathion, Cythion, Emmaton, Emmatos, Emmatos Extra, ForMal, Fyfanon, Karbofos, Karbophos, Kop-Thion, Kypfos, Malamar, Malaspray, malathion, mercapothion MLT, Zithiol	NF	Insecticide
MCPA	C ₉ H ₉ ClO ₃	4-[(4-chloro-o-tolyl)oxy] acetic acid	Agroxone, Bordermaster, Chiptox, Hormotuho, M 40, MCP, Mephanac, Metaxon, Methoxone, Phenoxylene Plus, Rhomene, Rhonax, U 46, Weedar, Zelan	825 mg/L	Herbicide
Methoxychlor	C ₁₆ H ₁₅ Cl ₃ O ₂	1, 1, 1-trichloro-2, 2-bis (p-methoxyphenyl) ethane	dimethoxy-DT, DMDT, Marlate methoxy-DDT metossichloro, Moxie	NF	Insecticide
Methyl Parathion	C ₈ H ₁₀ NO ₅ PS	o, o-dimethyl o-(p-nitrophenyl) phosphorothioate	Dalf, dimethyl parathion, E 610, Folidol M, Fosferno M 50, Gearphos, Metacide, Metaphos, Metron, nitrox, Nitrox 80, Parathion-methyl Partron M, Penncap-M, Tekwaisa, Wolftox	60 mg/L	Insecticide
Methyl Trithion	C ₉ H ₁₀ ClO ₂ PS ₃	s-[(p-chlorophenylthio) methyl] o, o-dimethyl phosphorodithioate	Methyl carbophenothian, R 1492, Tri-Me	NF	Insecticide
Metribuzin	C ₈ H ₁₄ N ₄ OS	4-amino-6-tert-butyl-3-(methylthio)-1, 2, 4-triazin-5-on	Bay 94337, Lexone, metribuzine, Sencor, Sencoral, Sencorer, Sencorex	1 200 mg/L	Herbicide
Mirex	C ₁₀ Cl ₁₂	dodecachlorooctahydro-1, 3, 4-metheno-2H-cyclobuta[c, d] pentalene	Dechlorane, GC 1283	NF	Insecticide
Paraquat	C ₁₂ H ₁₄ N ₂	1, 1'-dimethyl-4, 4'-bipyridylum ion	Dextrone, Gramoxone, Weedol	NF	Herbicide
Parathion	C ₁₀ H ₁₄ NO ₅ PS	o, o-Diethyl o-(p-nitrophenyl) phosphorothioate	AC 3422, Alkron, Alleron, Aphamite, ATT, Bladan, Corothion, Danthion, E-605, ENT 15108, Ethyl Parathion, Etilon, Folidol, Fosferno, Niran, Nitrostigmine, Parathene, Paramar, Paraphos, Parawet, Phoskil, Rhodiattox, SNP, Soprathion, Stathion, Thiophos	24 mg/L	Insecticide

TABLE B: ALPHABETIC LISTING OF PESTICIDES (ON NAQUADAT) INCLUDING COMMON, SCIENTIFIC, AND BRAND NAMES
(continued)

Common Name	Empirical Chemical Formula	Chemical Name or Definition	Other Names	Solubility in Water	Primary Use
Perthane	$C_{18}H_{20}Cl_2$	1, 1-dichloro-2, 2-bis (p-ethylphenyl) ethane	ethylan, (p, p'-ethyl-DDD) Q-137	NF	Insecticide
Phorate	$C_7H_{17}O_2PS_3$	o, o-diethyl S-(ethylthiomethyl) phosphorodithioate	Granutox, Thimex, timet, Rampart	50 mg/L	Insecticide
Phosalone	$C_{12}H_{15}ClNO_4PS_2$	S-[(6-chloro-2-oxo-3-benzoxazolyl)methyl]o,o-diethyl phosphorodithioate	RP 11974, Rubitox, Zolone	insoluble	Insecticide
Phosdrin	$C_7H_{13}O_6P$	dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate	Mevinphos, Os-2046	Soluble	Insecticide
Phosmet	$C_{11}H_{12}NO_2PS_2$	o, o-dimethyl phtalimidomethyl phosphorodithioate	Appa, Imidan, phtalophos, PMP, Prolate R 1504	NF	Insecticide
Phosphamidon	$C_{10}H_{19}ClNO_5P$	2-chloro-N-diethyl-3-hydroxycrotonamide dimethyl phosphate	C 570, Dimecron, fosfamidone	miscible	Insecticide
Picloram	$C_6H_3Cl_3N_2O_2$	4-amino-3, 5, 6-trichloropicolinic acid	Borolin, K-Pin, Tordon	430 mg/L	Herbicide
Prometone	$C_{10}H_{19}N_5O$	2, 4-bis(isopropylamino)-6-methoxy-s-triazine	Gesafram, Pramitol, Primatol O, prometone,	750 mg/L	Herbicide
Ronnel	$C_8H_8Cl_3O_3PS$	o, o-dimethyl o-2, 4, 5-trichlorophenyl phosphorothioate	Ectoral, Etrolene, fenchlorfos, Korlan Nankor, Trolene, Viozene	NF	Insecticide
Silvex	$C_9H_7Cl_3O_2$	2-(2, 4, 5-trichlorophenoxy) propionic acid	Aqua-Vex, Ded-Weed, Fenoprop, Fruitone T, Garlon, Kuron, Kurosai, O-X-D, Silvi-Rhap, 2, 4, 5-TP	140 mg/L	Herbicide
Simazine	$C_7H_{12}ClN_5$	2-chloro-4, 6-bis-ethylamino-s-triazine	Amizine, CDT, CET, Gesapun, Gesatop, Primatol, Primatol S, Princep, Simanex	<5 mg/L	Herbicide
TCA	$C_2HCl_3O_2$	trichloroacetic acid	Nata, Varitox	very soluble	Herbicide
Toxaphene	$C_{10}H_xCl_y$	chlorinated camphene containing 67-69% chlorine	Alltox, Camphechlor, Chem-phene, Chlor Chem T 590, Cristoxo, Estonox, Geniphene, Gy-phene, Motox, octachlorocamphene, Phenacide, Phenatox, polychlorcamphene, Strobane-T, Toxadust, Toxakil, Toxaspra, Toxon 63	insoluble	Insecticide
Trifluralin	$C_{13}H_{16}F_3N_3O_4$	α, α, α -trifluoro-2, 6-dinitro-N, N-dipropyl-p-toluidine	Carpiclor, Elancolan, Su Seguro, Trefanocide, Treficon, Treflan EC, Triflurex, Trim	24 mg/L	Herbicide
Trithion	$C_{11}H_{16}ClO_2PS_3$	S-[(p-chlorophenylthio)methyl] o, o-diethyl phosphorodithioate	Acarithion, carbophenothion, Dagadip, Garraithion, Lethox, R 1313	NF	Insecticide
2, 4-D	$C_8H_9Cl_2O_3$	2,4-dichlorophenoxyacetic acid	Agrotext, Amoxone, Aqua-Kleen, Chipco Turf Herbicide 'D', Chloroxone, Crop Rider, D50, Dacamine, Ded-Weed, Dormone, Esteron, Esterone, Fernesta, insoluble	Salts - water sol. Acids/esters	Herbicide

TABLE B: ALPHABETIC LISTING OF PESTICIDES (ON NAQUADAT) INCLUDING COMMON, SCIENTIFIC, AND BRAND NAMES (concluded)

Common Name	Empirical Chemical Formula	Chemical Name or Definition	Other Names	Solubility in Water	Primary Use
			Fernamine, Fernoxone, Feroxone, Formula 40, Hedonal, Lawn-Keep, Macondray, Miracle, Pennamine D, Planotox, Plantgard, Salvo, Tributon, U46, Vergemaster, Vertron 2D, Visko-Rhap Low Volatile 4L, Weebar, Weedar, Weedeze, Weedone, Weed-Rhap, Wonder Bar		
2, 4-DB	$C_{10}H_{10}ClO_3$	4-(2, 4-dichlorophenoxy) butyric acid	Butoxone SB, Butyrac, Embutox	readily sol.	Herbicide
2, 4-DP	$C_9H_8O_3Cl_2$	2-(2, 4-dichlorophenoxy) propionic acid	Cronox-RD, Dichloroprop, Fernoxone, RD 406	350 mg/L	Herbicide
2, 4, 5-T	$C_8H_5Cl_3O_3$	2, 4, 5-trichlorophenoxyacetic acid	Brush Killer, Brush Rhap, Dacamine, Ded-Weed, Esterone, Esterone 245, Fence Rider, Fruitone A, Forron, Inverton 245, Line Rider, Peddiox, Reddon, Spontox, Tormona, Tributon, Trimoxol, Trioxone, U 46, Weedar, Weedone	soluble	Herbicide

Generally, the impact of a pesticide extends beyond the target organism (the "pest") by altering environmental conditions required by other organisms which do not adversely affect man's use of the environment. Pesticides also accumulate in the food web. In the case of the aquatic environment, caution must be exercised in assessing and formulating water quality guidelines based solely on the concentrations found in the water, since substantial amounts may be present in the sediments and adsorbed on particulate material.

pH

pH indicates the balance between the acids and bases in water and is a measure of the hydrogen ion concentration in solution. pH values reflect the solvent power of water, thereby indicating its possible chemical reactions on rocks and soils.

Environmental Range

As an index of the hydrogen ion concentration, pH is measured on a scale from 0 to 14. A value of 7 indicates a neutral condition; values less than 7 indicate acid

conditions, while values greater than 7 indicate basic conditions in a water. Natural waters range from 4 to 9 as controlled by the bicarbonate-carbonate system. Surface waters generally tend to be basic, whereas groundwaters are more acidic. The range of pH is greater in freshwaters than seawater; seawater ranges from 8.0 to 8.3 pH units.

Sources

The presence of carbonates, hydroxides, and bicarbonates increase the basicity of water, while the presence of free mineral acids and carbonic acids increase acidity. Acid waters are less common than alkaline waters.

Acid mine drainage and industrial wastes which have not been neutralized may significantly decrease the pH of the water.

Water Quality Guidelines

Drinking water standards propose a pH range from 6.5 to 8.3 pH units provided other criteria are acceptable. If the pH is outside this range, an evaluation of the

cause and its effects must be ascertained. pH greater than 8.3 interferes with the disinfection process of drinking waters.

The pH of the water may influence the species composition of an aquatic environment and affect the availability of nutrients and the relative toxicity of many trace elements.

The objective for the protection of the aquatic environment recommends that the pH should fall within the range of 6.5 to 9 units, also that discharges should not alter the ambient pH by more than 0.5 pH units in the mixing zones (Gt. Lakes Wat. Qual., 1976b).

An identical range has been suggested to meet aesthetic and recreational uses. pH values above 9 may decrease the solubility of calcium carbonate, causing a precipitate and thus a milky appearance of the water.

Effects on Use

The pH of water supplies is adjusted to control corrosion in its distribution system. Industries such as bleaching, brewing, photography, electro-plating, ore dressing, and photo-engraving are also affected by the pH of their water supplies. Thus, pH is important in determining the treatment of water supplies.

PHOSPHORUS

Phosphorus, a non-metallic element, can occur in numerous forms, organic or inorganic, and as a dissolved or particulate species. Since phosphorus is an essential plant nutrient, it may be a limiting factor for plant growth. In water the combined form of the element is continually changing due to the processes of decomposition and synthesis between organically bound forms and oxidized inorganic forms.

Environmental Range

Phosphorus is rarely found in significant concentrations in surface waters, as it is actively taken up by plants. Groundwaters may contain somewhat higher concentrations. The total phosphorus concentration in uncontaminated lakes is in the order of 0.01 mg/L phosphorus.

Sources

Phosphorus may be leached or weathered from igneous rocks. The mineral apatite and the decomposition of organic matter are two other natural sources of phosphorus, however, apatite-phosphorus is not biologically available.

Domestic sewage containing human excrement and phosphates from detergents, industrial effluents, and agricultural drainage from fertilized land contribute phosphorus to waters. Phosphates may be added to water supplies to prevent scale formation, inhibit corrosion, and in addition, enhance laundry and cleaning efficiencies. Phosphorus is subject to atmospheric transport and deposition.

Water Quality Guidelines

Phosphorus is not commonly toxic to man, animals, or fish and is an essential element for plant growth. Only the extremely rare form of elemental phosphorus is toxic.

Regulation of the phosphorus content of household detergents and guidelines on phosphorus concentrations in sewage plant discharges have been established largely to reduce eutrophication of water systems. Its presence may stimulate algal growth, which may be of aesthetic concern in recreational areas. A general index of maximum desirable concentrations is: 0.10 mg/L in flowing water, 0.05 mg/L for water flowing into lakes and reservoirs, and 0.025 mg/L in lakes and reservoirs.

Water quality guidelines have been proposed to eliminate taste and odour problems and difficulties of water treatment which can be associated with phosphorus. A concentration of 0.2 mg/L has been defined as maximum permissible limit for acceptable drinking water (Dep. of Nat. Health & Welfare, 1969).

Effects on Use

When sufficient nitrogen compounds are present, phosphorus concentrations above 0.1 mg/L in water may prove troublesome by promoting the development of slimes and algal growth, which affect municipal, industrial, and recreational uses. High concentrations may, however, be detrimental in food preparation because of the buffering capacity of phosphates.

POTASSIUM

Although potassium constitutes about 2.5 per cent of the earth's crust and is one of the principal alkalis present in water, it is only found in quantities of a few parts per million in water. Both sodium and potassium are alkali metals with similar chemical characteristics except for their behaviour to weathering. After leaching, sodium remains in solution, whereas potassium usually becomes incorporated into new stable minerals. Potassium is an essential element for plant and animal nutrition.

Environmental Range

The concentration of potassium in natural surface waters seldom reaches 20 mg/L and is generally less than 10 mg/L. Concentrations of 100 mg/L have been found to occur in hot springs. Seawater contains 380 mg/L of potassium, while brines may contain up to 25 000 mg/L. Most Canadian surface waters are low in alkali metals, except for groundwaters. The sodium-potassium ratio in natural waters ranges from 2:1 to 3:1 with the proportion of sodium increasing with increasing total concentration.

Sources

Although potassium may be found in many rocks, those with significant amounts of potassium are resistant to weathering, and evaporitic rocks containing large amounts of potassium do not occur frequently. Feldspar, feldspathoids, micas, and clay minerals all contain appreciable amounts of potassium. Industrial effluents and water contact with potassium-bearing soils may contribute potassium to surface waters.

Water Quality Guidelines

Moderate quantities of potassium do not detrimentally affect the utility of a water. Although potassium is an essential nutrient to plant and animal life, very high concentrations (>2 000 mg/L) of potassium may be harmful to the human nervous and digestive systems. No recommended limit has been prescribed for potassium.

Effects on Use

If both potassium and sodium are present together in quantities from 50 to 100 mg/L, certain industries may be affected, since foaming, scale, or corrosion may result

upon heating. Wood used in cooling towers is subject to deterioration and ice manufacturers have problems when total alkali concentrations exceed 65 mg/L.

SATURATION INDEX

The Langelier Saturation Index is a numerical value which indicates the scale-forming or corrosive properties of a water. The Saturation Index is calculated by the following formula:

$$\text{Saturation Index} = (\text{pH}_s - \text{pH})$$

where

pH is actual pH of the water

pH_s is saturation pH with respect to calcium carbonate

Parameters affecting this index are temperature, pH, alkalinity, and dissolved solids.

Water Quality Guidelines

No water quality guidelines have been proposed for the Saturation Index. A Saturation Index value of zero indicates a stable water in which calcium carbonate is at equilibrium. Positive values indicate over-saturation with respect to calcium carbonate and are likely to form a scale, whereas negative values indicate undersaturation and thus are apt to be corrosive. Values outside the range ± 0.75 pH units tend to exhibit the aforementioned characteristics.

Effects on Use

Scale-forming or corrosive characteristics of water are of principal concern to industries.

SILICA

Silicon (Si) ranks as the second most abundant element in the earth's crust, and silica (SiO₂) can be found in most natural surface waters. Silica is insoluble in most natural waters or acids and usually occurs in the colloidal state. Certain algae (diatoms) require silica for frustule growth, but this constituent may be regenerated at the end of their life cycle.

Environmental Range

Most natural waters contain less than 5 mg/L of silica, although a range from 1 to 30 mg/L is not uncommon. Groundwater, especially hot springs, may contain as much as 65 mg/L and waters flowing through volcanic rocks may contain silica concentrations exceeding 100 mg/L. Brackish and saline waters may range from 1 000 to 4 000 mg/L silica. Typical Canadian surface waters exhibit a silica concentration of 3 to 4 mg/L.

Sources

Although silica is present in virtually all rocks, it is most easily leached from sedimentary rocks and clay minerals. Quartz, feldspar, and other silicate minerals provide additional supplies of silica. Sources of silica are primarily natural, although the fluoridation of drinking water and the use of aerosols may provide additional inputs.

Water Quality Guidelines

The presence of silica in water is not detrimental to humans, fish, or livestock. The use of water for municipal, domestic, or agricultural purposes is unaffected by silica, however, industry may find silica troublesome in boilers due to the formation of siliceous deposits. No guidelines specifying concentrations of silica in water have been established.

Effects on Use

Silica can form a heat retardant scale on boiler walls and on steam turbine blades when combined with calcium and magnesium.

SODIUM

Sodium, the principal alkali metal, is found in an ionic form in all surface waters. Nearly all sodium compounds are readily soluble in water and tend to remain in aqueous solution. Sodium is an important cation and significant in the balance of total cations. It is usually found in association with potassium.

Environmental Range

All natural waters contain some sodium. The sodium concentration in water ranges from 1 mg/L to 100 000 mg/L. Leaching of evaporitic deposits results in high sodium concentrations in water. In most areas, groundwater sodium concentrations are somewhat elevated over their surface water counterparts. Seawaters contain 10 000 mg/L of sodium. Brines may range from 25 000 mg/L to 100 000 mg/L.

Sources

Water in contact with igneous rocks provides a natural source of sodium. Clay minerals, feldspars, feldspathoids, and evaporitic minerals such as halite and mirabilite are potential natural sources of sodium to water.

Sodium salts are widely used in industry, so industrial wastes may discharge sodium into receiving waters. Municipal sewage and oil field drainage may also supply sodium to receiving waters. Sodium salts are used in road de-icing and thus contribute sodium to surface waters.

Water Quality Guidelines

Sodium is used in the normal functioning processes of the human body but may prove of concern to those with cardiac, renal and circulatory problems. People on a restricted sodium diet would not be advised to use waters whose sodium concentrations exceed 20 mg/L for drinking. Waters whose concentrations of sodium do not exceed 270 mg/L can be deemed generally acceptable for drinking (Hart, 1974).

Plants use sodium in limited amounts for growth, but the presence of large amounts of sodium often proves injurious, especially to fruit crops. Sodium can adversely affect soil structure and create alkali soils, which impair agricultural uses. The sodium criteria for irrigation waters is discussed in the section Sodium Adsorption Ratio.

Effects on Use

Sodium may restrict the use of a water for drinking but its impact on agricultural uses is much greater. Sodium in excess of 2 mg/L in boiler water may result in foaming. Adverse effects of sodium are enhanced by potassium; these are discussed in relation to potassium.

SODIUM ADSORPTION RATIO

The Sodium Adsorption Ratio (SAR) is important in evaluating the suitability of waters used for agricultural irrigation. This ratio is an estimate of the degree to which sodium will be adsorbed by a soil from a water. The value is calculated from the ionic concentration of sodium, calcium, and magnesium according to the following equation:

$$SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}}$$

(Concentrations in milliequivalents per litre)

The Sodium Adsorption Ratio evaluates the potential base exchange relationships in which calcium and magnesium in a soil are replaced by the sodium present in the water.

Water Quality Guideline

Sodium in irrigation waters adversely affects soil structure and permeability by replacing calcium and magnesium, therefore, irrigation waters have to be closely monitored to minimize such effects.

Waters have been classified according to their sodium or alkali hazard. At a specific conductance of 100 $\mu S/cm$, the sodium concentrations related to low, medium, high, and very high sodium hazard are <10, 10-18, 18-26, >26 respectively, whereas at a specific conductance of 5 000 $\mu S/cm$ these values are <2.5, 2.5-6.5, 6.5-11.0, >11.0 respectively (US Geol. Surv., 1974).

Figure 4 presents the sodium adsorption fields relative to sodium and calcium and magnesium concentrations.

Generally, sensitive fruit crops should not be subjected to waters with SAR values in excess of 4, while less sensitive crops can withstand up to 7 (Agri. Canada). Waters with SAR values greater than 7 should be avoided, as they seriously reduce soil permeability.

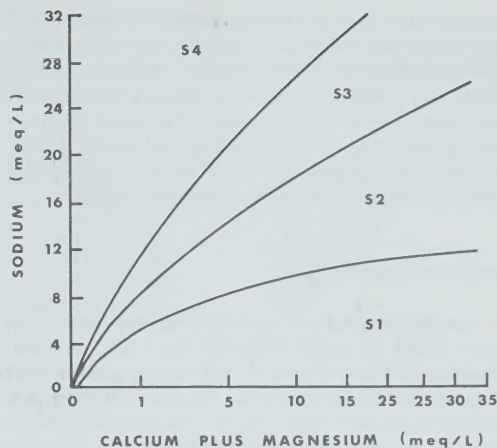


Figure 4. Sodium adsorption fields. Source: Hart, 1974.

Fields:

- S1 Low-Sodium Water – can be used on all soils
- S2 Medium-Sodium Water – can be used on organic and coarse-textured soils. Possible problem with fine-textured soils.
- S3 High-Sodium Water – troublesome with most soils
- S4 Very High-Sodium Water – unsatisfactory for irrigation

Effects on Use

The sodium content of water may compromise its applicability for irrigation of farmland. Consult the section on sodium for complete discussion of this parameter.

SPECIFIC CONDUCTANCE

Specific conductance (conductivity) is a numerical expression of a water's ability to conduct an electrical current. It is measured in microsiemens per centimetre ($\mu S/cm$) corrected to a standard temperature, usually 25°C. The conductivity of water is dependent on its ionic concentrations and temperature.

Specific conductance provides a good indication of changes in a water's composition, especially in its mineral

concentration. It is particularly sensitive to variations of dissolved solids, but provides no indication of the relative quantities of the various components. As more dissolved solids are added, the water's specific conductivity increases. An empirical relationship exists between specific conductance and total dissolved solids; specific conductance multiplied by 0.65 closely approximates total dissolved solids (Bayly, and Williams, 1973).

Environmental Range

Specific conductance in natural surface waters has been found to range from 50 to 1 500 $\mu\text{S}/\text{cm}$. Groundwaters and waters in arid regions usually have elevated specific conductance. The conductivity of arid waters is typically 1 000 $\mu\text{S}/\text{cm}$. The specific conductance of seawater is typically expressed in terms of salinity. Specific conductance in surface water is usually highest when groundwater infiltration provides a significant portion of the streamflow and is lowest in spring when waters from melting snows provide dilution.

Industrial wastes can elevate the specific conductance of receiving waters to 10 000 $\mu\text{S}/\text{cm}$.

Water Quality Guidelines

No guidelines have been established to regulate specific conductance, since the high values are found to correlate with total dissolved solids, which have outlined objectives.

Effects on Use

Values of high specific conductance reflect the presence of high concentrations of total dissolved solids. The effects of these are discussed under total dissolved solids.

STABILITY INDEX

The Ryznar Stability Index is a numerical value that indicates the degree to which waters may cause scale or corrosion. The Stability Index is calculated by the formula

$$\text{Stability Index} = (2\text{pH}_s - \text{pH})$$

where

pH is the actual pH of the water

pH_s is saturation pH with respect to calcium carbonate

Parameters affecting this index are temperature, pH, alkalinity, and total dissolved solids.

Water Quality Guidelines

No water quality criteria have been proposed for the Stability Index, however, waters may be classified in terms of their scale-forming or corrosive characteristics as noted in the table below.

Stability Index	Characteristics
3 — 4	Excessively heavy scale at 15°C and above
4 — 5	Heavy scale at 15°C and above
5 — 6	Scale at 15°C; heavy scale at 65°C and above
6 — 7	Mild scale to no scale; negligible corrosion
7 — 8	Negligible corrosion in waters below 15°C; corrosion at 65°C and above
8 — 9	Moderate to heavy corrosion in water below 15°C
9 — 10	Severe corrosion in warm waters
10 and above	Extreme severe corrosion at 15°C and above

Effects on Use

Scale-forming or corrosive characteristics of water are of prime concern to many industries.

SULPHATE

Sulphate (SO_4^{2-}) is the stable highly oxidized form of sulphur. It can be produced by the bacterial oxidation of reduced sulphur compounds, including metallic sulphides and organo-sulphur compounds. The sulphate ion is readily soluble in water.

Environmental Range

Concentrations of sulphate may vary from a few to thousands of milligrams per litre in surface waters. High sulphate concentrations are present in some well waters and surface waters in arid regions where sulphate minerals are present. Areas of acid mine drainage may also have elevated levels. Brines can exhibit concentrations of 200 000 mg/L.

Sources

Sulphates may be leached from most sedimentary rocks including shales, with the most appreciable contributions from sulphate deposits (gypsum and anhydrite). Upon oxidation, organic materials may contribute sulphates to waters. Industrial discharges from tanneries, sulphate-pulp mills, textile plants using sulphates, or sulphuric acid and some metal working industries may input sulphates into waters. Both wet and dry atmospheric precipitation contain sulphates as a result of burning fossil fuels.

Water Quality Guidelines

Moderately high concentrations of sulphate (200–300 mg/L) may be objectionable in water, and magnesium sulphate may be cathartic to humans. Although a laxative effect may be experienced when concentrations range between 150–500 mg/L, an objective for drinking water has been proposed at 250 mg/L. Concentrations up to 500 mg/L are still deemed permissible for drinking. Waters with concentrations in excess of 500 mg/L may have a bitter objectionable taste and result in gastro-intestinal irritation and catharsis; they are, therefore, not recommended for human consumption. Livestock water may contain concentrations of up to 1 000 mg/L and still be considered acceptable (Hart, 1974). Sulphate concentrations seldom become high enough to adversely affect aquatic life.

Effects on Use

High concentrations of sulphate restrict a water's use as a drinking source. Concentrations in excess of 250 mg/L may restrict the use of a water by certain industries. A hard scale of calcium sulphate may be formed in pipes, condensers, and boilers. Beverage and ice plants must limit the amount of sulphate present in the water that they use. Sulphate can corrode concrete.

TOTAL DISSOLVED SOLIDS

Total Dissolved Solids (TDS) is an index of the amount of dissolved substances in a water. The presence of such solutes alters the physical and chemical properties of water.

Environmental Range

The range of dissolved solids is variable and is tabulated below:

Total Dissolved Solids	Degree of Salinity
0 — 1 000	Fresh non-saline
1 001 — 3 000	Slightly saline
3 001 — 10 000	Moderately saline
10 001 — 100 000	Saline
>100 001	Brine

Sources

The base flow of a waterway acquires mineral constituents in the form of dissolved salts in solution, such as sodium, magnesium, potassium, etc. In periods of high surface runoff, overland flow contributes dissolved materials to waters. In addition, significant contributions to the TDS load are anthropogenic in the form of municipal and industrial effluents, agricultural runoff, and aerosol fallout.

Water Quality Guidelines

Basic guidelines on the concentration of TDS which have been established relate to taste and palatability qualities rather than to any detrimental health effects on man and aquatic biota. Water whose TDS concentration is less than 500 mg/L has been designated as an objective level for drinking water (Dept. of Nat. Health & Welfare, 1969). It has been recognized that concentrations of 1 000 mg/L may still be acceptable for drinking providing none of the individual dissolved constituents exceed their particular guidelines (Dept. of Nat. Health & Welfare, 1969). If the concentration exceeds 2 000 mg/L definite laxative effects have been observed in man.

A similar laxative effect has been shown in livestock. For animals concentrations less than 3 000 mg/L have proven to be satisfactory in most circumstances (Environ. Stud. Bd., 1973).

Industrial users of waters usually prescribe TDS concentrations to be less than 1 000 mg/L, but this is quite variable among individual users and their particular requirements (US Geol. Surv., 1960).

Effects on Use

High concentrations of TDS limit the suitability of a water as a drinking source. Industries are sensitive to boiler scale or to accelerated corrosion associated with substantial amounts of TDS in water. High TDS waters may interfere with the clarity, colour, and taste of manufactured products.

TURBIDITY

Turbidity is a measure of the suspended particles such as silt, clay, organic matter, plankton, and microscopic organisms in water which are typically held in suspension by turbulent flow and by Brownian movement. Turbidity is measured by comparing the optical interferences of suspended particles to the transmission of light in water in an instrument previously standardized with samples of standard turbidity units.

Environmental Range

It is impractical to assign a range of values to turbidity, however, non-detectable turbidity may be approximated by pure distilled water (~0 Jackson Turbidity Units (JTU)). Values of 1 000 JTU may be encountered in waste-waters; waters with very high natural turbidity may be in the range of several hundred JTU.

Sources

The amount of solid materials in suspension in water may result from natural erosion, runoff, and algal blooms, although man may contribute to the presence of such materials. The concentration and particle size of these suspended materials may cause significant variation of turbidity values. High turbidity is experienced during spring runoff.

Water Quality Guidelines

High turbidity reduces photosynthesis of submerged, rooted aquatic vegetation and algae; this reduced plant growth may in turn suppress fish productivity. Turbidity, therefore, can affect aquatic biological communities. Water quality guidelines stipulate that discharges resulting from human activity should not alter ambient turbidity levels.

Turbidity, unless related to asbestiform minerals, does not affect the safety of a drinking water, but does alter its consumer acceptability. Although water with a turbidity of less than 5 JTU can be used for drinking, a value of 1 JTU has been recommended (Dept. of Nat. Health & Welfare, 1969).

Turbidity also affects recreational uses of water and recommendations for water with direct recreational contact range from 5 to 50 JTUs.

Effects on Use

High turbidity adversely affects domestic, industrial, and recreational uses of a water. Often some of this suspended matter has to be removed prior to industrial use, since highly turbid waters are abrasive to pumps, pipes, and turbine blades. Turbidity puts an excess load on water treatment plants by interfering with disinfection and generating extra sludge.

ZINC

Although zinc is abundant in nature, elemental zinc and zinc oxide are only sparingly soluble in water. Zinc chlorides and sulphates are highly soluble, therefore, the concentration in water depends on the chemical compound of zinc that is present. Zinc ions are readily adsorbed on sediments and soils. Dissolved silica in water enhances zinc concentration, since zinc chemically binds with silica. The solubility of zinc increases as the water becomes more acidic.

Environmental Range

Usually zinc is present in trace amounts in both ground and surface waters (i.e. less than 0.05 mg/L). Areas with naturally acidic water and mining areas, however, may potentially contain up to 50 mg/L. Seawater typically contains 0.01 mg/L zinc.

Sources

Two important sources of zinc are its sulphide (sphalerite) and oxide (maranite). Zinc often occurs in combination with two or more sulphides such as copper-zinc and copper-lead-zinc ores. Calcareous sediments may also contribute zinc to the aquatic environment.

Zinc is widely used in industry. Zinc oxides are used in paints, rubber, textiles and other chemicals. Printing operations, fertilizers, pesticides, and the burning of fossil fuels may further contribute zinc to the environment; areas around lead-zinc smelters are of particular concern.

Water Quality Guidelines

Zinc is an essential element for plants, animals, and man because it is necessary for the functioning of certain enzymes. Zinc is relatively non-toxic to man. Concentrations of zinc up to 25 mg/L have shown few adverse effects. Water with a high zinc concentrations has a milky appearance and produces a greasy film upon boiling. Drinking water criteria are based on aesthetic considerations and propose that zinc concentrations should not exceed 5 mg/L in raw and public drinking water supplies.

Animals can also tolerate zinc in their drinking water without detrimental effects, however, it has been proposed that such water should not exceed concentrations of 25 mg/L zinc.

Zinc is an essential nutrient for plants and only at the elevated concentrations encountered in mining areas has zinc been shown to be toxic. If pH values are above 6.0, zinc concentrations in irrigation water can be 2 mg/L for acidic soils and 10 mg/L for neutral and alkaline soils (Environ. Stud. Bd., 1973).

Zinc, however, is acutely and chronically toxic to aquatic organisms, particularly fish. The toxicity is dependent on a number of factors: zinc toxicity to aquatic life decreases with increasing hardness (i.e. calcium and magnesium concentrations); the toxicity of zinc increases with increasing temperature and decreasing dissolved oxygen and the presence of copper and cadmium enhances zinc's sublethal toxicity. Guidelines to protect aquatic life specify that zinc concentrations should not exceed 0.03 mg/L in unfiltered water samples, (Gt. Lakes Wat. Qual. Bd., 1976a).

Effects on Use

High zinc concentrations harm primarily aquatic life but can also restrict the use of a water as a public drinking water source.

Glossary

Adsorption:	the attachment of a substance on the surface of another.
Aerobic:	denotes the presence of gaseous or dissolved oxygen, (cf. anaerobic).
Aerosol:	the dispersion of either a liquid or a solid material in a gas phase (e.g. air).
Algae:	a group of simple chlorophyll-containing (green) lower plants, mostly aquatic; although most are microscopic, some forms reach extremely large sizes.
Algal Bloom:	a bloom of certain planktonic algae occurs when their growth is so rapid that they become numerous enough to colour a body of water.
Alkaline Earths:	metals in group IIA of the Periodic Table that typically form oxides and carbonates (beryllium, magnesium, calcium, strontium, barium, and radium).
Alluvial Deposits:	deposits of silt, sand, etc. left by water (e.g. stream) flowing over land that is not usually submerged.
Amphoteric:	capable of acting either as an acid or a base in a chemical reaction.
Anaemia:	a deficiency of either the number of red blood cells or the amount of hemoglobin in the red blood cells.
Anthropogenic:	relates to or involves the impact of man.
Bioaccumulation:	the uptake, retention, and thus concentration above background levels of environmental substances by an organism from its environment.
Biota:	living organisms including bacteria, plants, and animals.
Blue-Green Algae:	a group of simple lower plants containing both blue and green pigmentation. They often produce algal blooms.
Brackish:	water with less salt than seawater, but undrinkable. Waters having salinity values between 0.5 and 17 parts per thousand.
Brine:	concentrated saline water containing more than 36 000 mg/L of total dissolved solids.
Brownian Movement:	the random movement of microscopic particles suspended in a gas or liquid.
Buffer:	a compound or solution capable of resisting a change in pH.
Cardiac:	pertaining to the heart.
Catharsis:	purgation of the alimentary canal.
Colloid:	a state of matter intermediate between a true solution and a suspension where the material is typically less than 0.1 μm in size and greater than 1 nm.

Concretion:	a solid mass formed by the aggregation and cohesion of particles.
Diatoms:	unicellular or colonial algae having siliceous skeletons.
Diurnal:	daily; having a variation period of one day.
Emesis:	vomiting or act of vomiting.
Enzyme:	a protein that catalyzes a chemical reaction.
Eutrophication:	the natural process of ageing of water bodies involving nutrient enrichment, increasing organic production, and thus increasing organic sedimentation with its subsequent chemical effects.
Evaporitic Rocks:	sedimentary rocks deposited due to the evaporation of saline waters.
Frustule:	the two-valved siliceous skeleton of a diatom.
Heavy Metals:	metallic elements of high atomic weight (e.g. copper, lead, etc.) typically with specific gravities greater than 5.
Igneous Rocks:	rocks formed from the cooling and solidification of magma (molten rock).
Metamorphic Rock:	a rock that has been altered from its previous condition through the combined action of heat and pressure.
Methaemoglobinaemia:	a disease caused by methaemoglobin in the blood, which restricts the oxygen-carrying capacity of the blood.
Methylation:	the process whereby a compound is modified chemically (often through bacterial action) by the replacement of a hydrogen atom by a methyl group.
Milligrams Per Litre: (mg/L)	a concentration unit of chemical constituents in solution; the weight of solute per unit volume of solvent (water).
Mordant:	a chemical substance used for fixing colouring agents.
Nutrient:	an element or compound necessary for growth.
Palatability:	a condition of being agreeable to taste.
Pathogenic:	causing or capable of causing disease.
Percolation:	the downward movement of water through a soil.
Photosynthesis:	the process of carbohydrate production carried out by chlorophyll-containing (green) plants.
Physiological:	characteristic of, or appropriate to, an organism's healthy or normal functioning.
Phytotoxic:	poisonous to plants.
Potable Water:	drinkable and usable for culinary purposes.
Raw Water:	untreated surface or groundwater that can be used as a source of drinking water.

Saline:	waters having salt concentrations approaching that of seawater.
Sedimentary Rock:	a more or less consolidated rock formed from material deposited from suspension or precipitated from solution.
Sublethal:	involves a stimulus or effect below the level that causes death.
Symbiosis:	the intimate association of two organisms for mutual benefit.
Toxic:	pertaining to, due to, or of the nature of, a poison, thus toxicity; the quality of being poisonous.
Trace Element:	a chemical element found naturally or required by living organisms in extremely small quantities (micronutrient).

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Appendix III

Water Quality Stations: Numerical Index

PRINCE EDWARD ISLAND

WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
00PE01CA0001 MILL RIVER AT WSC GAUGE IN BLOOMFIELD PARK NORTH OF ST. ANTHONY, PRINCE COUNTY	46D 44M 39S	64D 10M 56S
00PE01CB0001 DUNK RIVER 5.5 KM EAST OF CENTRAL BEDEQUE, AT ROAD BRIDGE, PRINCE COUNTY		
00PE01CB0006 DUNK RIVER 1.6 KM WEST OF BREADALBANE, PRINCE COUNTY	46D 35M 29S	63D 52M 10S
00PE01CB0017 NORTH BROOK (LLOYDS BROOK) NORTH OF SOUTH FREETOWN, AT HWY BRIDGE, PRINCE COUNTY	46D 20M 49S	63D 37M 58S
00PE01CB0018 WILMOT RIVER SOUTH OF WILMOT VALLEY, PRINCE COUNTY	46D 23M 45S	63D 41M 41S
00PE01CB0019 DUNK RIVER AT LOWER BEDEQUE, PRINCE COUNTY	46D 20M 27S	63D 40M 8S
00PE01CB0020 SABLE RIVER NW OF HAMPTON, QUEENS COUNTY	46D 13M 39S	63D 26M 26S
00PE01CB0023 WESTMORLAND RIVER EAST OF CRAPAUD AT HWY 13 BRIDGE, QUEENS COUNTY	46D 14M 13S	63D 28M 49S
00PE01CB0025 UNNAMED RIVER NORTH OF AUGUSTINE COVE BELOW DAM, PRINCE COUNTY	46D 13M 45S	63D 36M 25S
00PE01CB0026 UNNAMED RIVER AT ROAD BRIDGE 100 M NORTH OF CAPE TRAVERSE, PRINCE COUNTY	46D 14M 35S	63D 38M 15S
00PE01CB0036 DE SABLE RIVER AT ROAD BRIDGE SOUTH OF HOLMS POND, QUEENS COUNTY	46D 12M 43S	63D 26M 4S
00PE01CB0037 GREENS BROOK FROM HWY BRIDGE ABOUT 1.5 KM NW OF DE SABLE, QUEENS COUNTY	46D 12M 30S	63D 25M 15S
00PE01CC0002 NORTH (YORKE) RIVER AT HWY 246 BRIDGE, MILTON STATION, QUEENS COUNTY	46D 18M 2S	63D 13M 21S
00PE01CC0004 WINTER RIVER 1.3 KM SOUTH OF PLEASANT GROVE, QUEENS COUNTY	46D 20M 13S	63D 6M 27S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
00PE01CC0005 AULD CREEK AT HWY 6 BRIDGE EAST OF COVEHEAD, QUEENS COUNTY	46D 23M 35S	63D 7M 19S
00PE01CC0010 CLYDE RIVER ABOUT 1.5 KM NORTH OF CLYDE RIVER ON HWY 247, QUEENS COUNTY	46D 14M 15S	63D 15M 53S
00PE01CC0012 HYDE (MILL) CREEK FROM HWY 248 BRIDGE EAST OF CORNWALL, QUEENS COUNTY	46D 13M 33S	63D 12M 53S
00PE01CC0013 FERGUSON CREEK FROM HWY 19 BRIDGE, SOUTH OF CHARLOTTETOWN, QUEENS COUNTY	46D 11M 13S	63D 10M 15S
00PE01CC0014 FULLERTON CREEK FROM ROAD BRIDGE WEST OF MOUNT HEBERT, QUEENS COUNTY	46D 13M 45S	63D 2M 23S
00PE01CC0015 MILL BROOK FROM HWY 6 BRIDGE ABOUT 1 KM SW OF NORTH RUSTICO, QUEENS COUNTY	46D 27M 8S	63D 19M 15S
00PE01CC0016 WINTER CREEK FROM HWY 6 BRIDGE EAST OF SOUTH RUSTICO, QUEENS COUNTY	46D 24M 50S	63D 17M 27S
00PE01CC0018 MATHESON (HORNES) CREEK FROM HWY 6 BRIDGE EAST OF OYSTER BED BRIDGE, QUEENS COUNTY	46D 23M 28S	63D 13M 49S
00PE01CC0019 BLACK RIVER FROM ROAD BRIDGE (DAM) SOUTH OF BRACKLEY BAY, QUEENS COUNTY	46D 23M 38S	63D 9M 53S
00PE01CC0020 MILL (BELLS) CREEK FROM ROAD BRIDGE WEST OF COVEHEAD, QUEENS COUNTY	46D 23M 38S	63D 7M 38S
00PE01CC0022 CLARKS (CLARK BROOK) CREEK FROM HWY 21 BRIDGE, AUGUSTUS, QUEENS COUNTY	46D 19M 45S	62D 53M 5S
00PE01CC0023 PISQUID RIVER FROM HWY 21 BRIDGE ABOUT 3 KM SOUTH OF MOUNT STEWART, QUEENS COUNTY	46D 20M 15S	62D 51M 38S
00PE01CC0024 JOHNSTONS (JOHNSTON) RIVER FROM HWY 21 BRIDGE SW OF GLENFINNAN, QUEENS COUNTY	46D 16M 25S	62D 59M 53S
00PE01CC0025 GLENFINNAN RIVER FROM ROAD BRIDGE 1 KM SE OF GLENFINNAN, QUEENS COUNTY	46D 17M 13S	62D 58M 3S
00PE01CC0038 LAKE OF SHINING WATERS OUTLET FROM HWY BRIDGE NW OF CAVENDISH, QUEENS COUNTY	46D 29M 55S	63D 23M 30S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
00PE01CD0003 MORELL RIVER FROM ROAD BRIDGE 1 KM WEST OF BANGOR, KINGS COUNTY	46D 21M 47S	62D 42M 11S
00PE01CD0005 MARIE RIVER FROM HWY 2 BRIDGE, MARIE, KINGS COUNTY	46D 24M 23S	62D 39M 27S
00PE01CD0006 ST. PETERS RIVER FROM ROAD BRIDGE BELOW BURGESS (QUIGLEYS) POND, KINGS COUNTY	46D 24M 23S	62D 32M 53S
00PE01CD0009 SOURIS RIVER FROM ROAD BRIDGE EAST OF GOWANBRAE, KINGS COUNTY	46D 23M 15S	62D 18M 45S
00PE01CD0010 NAUFRAGE RIVER FROM HWY 16 BRIDGE AT NAUFRAGE POND, KINGS COUNTY	46D 27M 45S	62D 25M 25S
00PE01CD0011 BEAR RIVER FROM HWY 16 BRIDGE, ST. MARGARETS, KINGS COUNTY	46D 27M 0S	62D 23M 0S
00PE01CD0012 HAY RIVER FROM HWY 16 BRIDGE ABOUT 1 KM EAST OF ST. MARGARETS, KINGS COUNTY	46D 27M 20S	62D 22M 0S
00PE01CD0013 CROSS RIVER FROM HWY 16 BRIDGE EAST OF HERMANVILLE, KINGS COUNTY	46D 27M 40S	62D 16M 8S
00PE01CD0014 EAST LAKE CREEK FROM HWY 16 BRIDGE KINGS COUNTY	46D 27M 0S	62D 1M 0S
00PE01CD0020 UNNAMED RIVER FROM HWY 16 BRIDGE PRIEST POND, KINGS COUNTY	46D 28M 40S	62D 10M 56S
00PE01CE0001 BRUDENELL RIVER 1 KM BELOW HWY 4 BRIDGE AT WSC GAUGE, KINGS COUNTY	46D 11M 58S	62D 38M 33S
00PE01CE0004 ORWELL RIVER AT UIGG, QUEENS COUNTY	46D 9M 17S	62D 48M 55S
00PE01CE0006 VERNON RIVER AT VERNON RIVER FROM HWY 24 BRIDGE, KINGS COUNTY	46D 12M 9S	62D 50M 15S
00PE01CE0007 ORWELL RIVER 4 KM SE OF VERNON BRIDGE AT HWY 1 BRIDGE, KINGS COUNTY	46D 9M 10S	62D 50M 19S
00PE01CE0008 NEWTON RIVER AT ROAD BRIDGE BELOW DAM KINGS COUNTY	46D 7M 20S	62D 50M 57S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
00PE01CE0009 PINETTE RIVER SOUTH OF ELDON AT HWY BRIDGE, BELOW DAM, KINGS COUNTY	46D 4M 48S	62D 52M 38S
00PE01CE0010 MIDDLE CREEK IN ROSEBERRY AT DAM ABOVE HWY 208 BRIDGE, KINGS COUNTY	46D 2M 20S	62D 52M 27S
00PE01CE0011 FLAT RIVER WEST OF BEATONS MILLS AT ROAD BRIDGE, KINGS COUNTY	46D 0M 45S	62D 51M 8S
00PE01CE0013 GREEK RIVER AT POINT PLEASANT (DAM) FROM HWY 17 BRIDGE, KINGS COUNTY	46D 2M 32S	62D 33M 53S
00PE01CE0014 STURGEON RIVER (SOUTH BRANCH) EAST OF MILLTOWN CROSS FROM HWY 345 BRIDGE, KINGS COUNTY	46D 6M 13S	62D 34M 49S
00PE01CE0015 STURGEON RIVER ABOVE MCKINNON POND AT HWY 317 BRIDGE, KINGS COUNTY	46D 6M 53S	62D 34M 16S
00PE01CE0016 VALLEYFIELD RIVER SOUTH OF MONTAGUE, KINGS COUNTY	46D 9M 16S	62D 39M 15S
00PE01CE0017 CARDIGAN RIVER AT CARDIGAN ABOVE HWY 321 BRIDGE, KINGS COUNTY	46D 13M 53S	62D 37M 8S
00PE01CE0018 MONTAGUE RIVER WEST OF MONTAGUE AT CAUSEWAY, KINGS COUNTY	46D 9M 43S	62D 39M 27S
00PE01CE0019 FOX RIVER EAST OF MURRAY RIVER FROM HWY 18 BRIDGE, KINGS COUNTY	46D 0M 25S	62D 34M 19S
00PE01CE0020 UNNAMED RIVER FROM HWY 1A BRIDGE ABOUT 0.8 KM EAST OF POWNAL, PRINCE COUNTY	46D 12M 22S	62D 57M 49S
01PE01CD0002 NORTH LAKE AT LAKEVILLE, KINGS COUNTY	46D 27M 0S	62D 6M 5S
01PE01CD0003 BLACK POND NEAR RED POINT AT HWY 16 BRIDGE, KINGS COUNTY	46D 22M 0S	62D 10M 0S
01PE01CE0001 MONTAGUE RIVER ABOVE HWY 320 BRIDGE, VICTORIA CROSS, KINGS COUNTY	46D 9M 33S	62D 40M 31S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
02PE01CA0001 SMELT CREEK ESTUARY AT CONFLUENCE OF BIDEFORD RIVER, AT FRB PUMP INTAKE, PRINCE COUNTY	46D 37M 2S	63D 54M 55S
02PE01CA0002 KILDARE RIVER ESTUARY IN CENTRE OF CHANNEL ABOUT 740 M NW OF HWY 2 BRIDGE IN MONTROSE, PRINCE COUNTY	46D 52M 52S	64D 4M 25S
02PE01CA0003 KILDARE RIVER ESTUARY IN CENTRE OF CHANNEL ABOUT 120 M NW OF HWY 2 BRIDGE IN MONTROSE, PRINCE COUNTY	46D 52M 7S	64D 4M 5S
02PE01CA0004 KILDARE RIVER ESTUARY IN CENTRE OF CHANNEL 160 M SOUTH OF HWY 2 BRIDGE, MONTROSE, PRINCE COUNTY	46D 52M 1S	64D 4M 0S
02PE01CA0005 KILDARE RIVER ESTUARY IN CENTRE OF CHANNEL 565 M SOUTH OF HWY 2 BRIDGE, MONTROSE, PRINCE COUNTY	46D 51M 48S	64D 3M 55S
02PE01CA0006 KILDARE RIVER ESTUARY IN NARROWEST CHANNEL 1280 M SOUTH OF HWY 2 BRIDGE, MONTROSE, PRINCE COUNTY	46D 51M 25S	64D 3M 50S
02PE01CA0007 HUNTLEY RIVER ESTUARY IN CENTRE OF CHANNEL ABOUT 350 M FROM MOUTH, PRINCE COUNTY	46D 51M 6S	64D 3M 54S
02PE01CA0008 KILDARE RIVER ESTUARY IN CENTRE OF CHANNEL ABOUT 2 KM NORTH OF CAUSEWAY, PRINCE COUNTY	46D 50M 59S	64D 3M 16S
02PE01CA0009 KILDARE RIVER ESTUARY IN CENTRE OF CHANNEL ABOUT 380 M NORTH OF CAUSEWAY, PRINCE COUNTY	46D 50M 14S	64D 3M 6S
02PE01CA0010 KILDARE RIVER ESTUARY IN CENTRE OF CHANNEL ABOUT 300 M NORTH OF CAUSEWAY, PRINCE COUNTY	46D 49M 58S	64D 2M 42S
02PE01CA0011 KILDARE RIVER ESTUARY IN CHANNEL, ABOUT 1300 M SE OF CAUSEWAY PRINCE COUNTY	46D 49M 46S	64D 1M 55S
02PE01CA0013 KILDARE RIVER ESTUARY IN EAST SHORE CHANNEL 1120 M NORTH OF KILDARE POINT, PRINCE COUNTY	46D 48M 54S	64D 2M 13S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
02PE01CB0001 SUMMERSIDE HARBOUR ESTUARY OF DUNK AND WILMOT RIVERS 360 M OFF WEST SHORE, SUMMERSIDE, PRINCE COUNTY	46D 23M 32S	63D 48M 9S
02PE01CB0002 SUMMERSIDE HARBOUR, BEDEQUE BAY, 1.6 KM SOUTH OF PHELAN POINT, PRINCE COUNTY	46D 22M 55S	63D 51M 13S
02PE01CB0003 SUMMERSIDE HARBOUR, BEDEQUE BAY, 1.6 KM WEST OF INDIAN HEAD, PRINCE COUNTY	46D 22M 15S	63D 49M 57S
02PE01CB0004 SUMMERSIDE HARBOUR ESTUARY OF DUNK AND WILMOT RIVERS 1.6 KM OFF WEST SHORE, SUMMERSIDE, PRINCE COUNTY	46D 23M 5S	63D 48M 42S
02PE01CB0005 SUMMERSIDE HARBOUR ESTUARY OF DUNK AND WILMOT RIVERS 1.1 KM OFF WEST SHORE, SUMMERSIDE, PRINCE COUNTY	46D 23M 17S	63D 48M 36S
02PE01CB0006 SUMMERSIDE HARBOUR AT WILMOT RIVER ESTUARY AT HWY 1A BRIDGE, PRINCE COUNTY	46D 23M 32S	63D 44M 6S
02PE01CB0007 SUMMERSIDE HARBOUR, BEDEQUE BAY, 450 M SW OF INDIAN HEAD, PRINCE COUNTY	46D 21M 52S	63D 49M 3S
02PE01CB0008 SUMMERSIDE HARBOUR ABOUT 198 M NORTH OF INDIAN HEAD AT END OF TREATMENT PLANT EFFLUENT PIPE, PRINCE COUNTY	46D 23M 22S	63D 48M 50S
02PE01CB0014 BARBARA WEIT RIVER ESTUARY FROM ROAD BRIDGE, CLERMONT STATION, PRINCE COUNTY PRINCE COUNTY	46D 25M 50S	64D 13M 26S
02PE01CB0017 TRYON RIVER AT TRYON FROM HWY 10 BRIDGE, KINGS COUNTY	46D 14M 13S	63D 32M 42S
02PE01CC0001 CHARLOTTETOWN HBR-HILLSBOROUGH ESTUARY ABOUT 800 M NORTH OF KELLY POINT, QUEENS COUNTY	46D 14M 51S	63D 5M 42S
02PE01CC0002 CHARLOTTETOWN HBR-HILLSBOROUGH ESTUARY ABOUT 800 M WEST OF KELLY COVE, QUEENS COUNTY	46D 14M 11S	63D 6M 43S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
02PE01CC0003 CHARLOTTETOWN HBR 150 M EAST OF TEXACO TERMINAL, 130 M SSE OF PAELWAY WHARF, QUEENS COUNTY	46D 13M 52S	63D 7M 9S
02PE01CC0004 CHARLOTTETOWN HARBOUR ABOUT 1350 M EAST OF FERRY POINT, QUEENS COUNTY	46D 13M 31S	63D 7M 29S
02PE01CC0005 CHARLOTTETOWN HARBOUR ABOUT 1800 M EAST OF FERRY POINT, QUEENS COUNTY	46D 13M 37S	63D 8M 7S
02PE01CC0006 CHARLOTTETOWN HBR-NORTH RIVER ESTUARY 1.2 KM EAST OF YORK POINT, QUEENS COUNTY NORTH RIVER WAS FORMERLY YORKE RIVER	46D 13M 34S	63D 9M 12S
02PE01CC0007 CHARLOTTETOWN HARBOUR, NORTH RIVER ESTUARY AT HWY 1 BRIDGE, QUEENS COUNTY NORTH RIVER WAS FORMERLY YORKE RIVER	46D 15M 26S	63D 11M 3S
02PE01CC0008 CHARLOTTETOWN HBR-WEST RIVER ESTUARY ABOUT 1 KM SOUTH OF CROSBY POINT, QUEENS COUNTY WEST RIVER WAS FORMERLY ELIOT RIVER	46D 11M 38S	63D 12M 19S
02PE01CC0009 CHARLOTTETOWN HBR-WEST RIVER ESTUARY ABOUT 270 M SOUTH OF NORTH POINT, QUEENS COUNTY WEST RIVER WAS FORMERLY ELIOT RIVER	46D 12M 40S	63D 9M 35S
02PE01CC0010 CHARLOTTETOWN HARBOUR ABOUT 0.80 KM NORTH OF ALCHORN POINT, QUEENS COUNTY	46D 12M 14S	63D 8M 4S
02PE01CC0011 CHARLOTTETOWN HARBOUR 1350 M SOUTH OF OLD BATTERY POINT, QUEENS COUNTY	46D 12M 59S	63D 8M 24S
02PE01CC0032 HUNTER RIVER ESTUARY IN CHANNEL CENTRE 2.4 KM DOWNSTREAM FROM HWY 6 BRIDGE, QUEENS COUNTY	46D 26M 37S	63D 18M 16S
02PE01CC0033 HUNTER RIVER ESTUARY 1080 M WEST OF LIGHTHOUSE, NORTH RUSTICO HARBOUR, QUEENS COUNTY	46D 27M 19S	63D 18M 29S
02PE01CC0034 HUNTER RIVER ESTUARY 270 M WEST OF LIGHTHOUSE, NORTH RUSTICO HARBOUR, QUEENS COUNTY	46D 27M 20S	63D 17M 48S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
02PE01CC0035 HUNTER RIVER ESTUARY ABOUT 225 M SW OF LIGHTHOUSE, NORTH RUSTICO HARBOUR, QUEENS COUNTY	46D 27M 11S	63D 17M 34S
02PE01CC0036 RUSTICO BAY IN CENTRE OF CHANNEL ABOUT 540 M NE OF TODD CREEK, QUEENS COUNTY	46D 26M 22S	63D 16M 22S
02PE01CC0037 RUSTICO BAY ABOUT 720 M NE OF GRAND PERE POINT, QUEENS COUNTY	46D 25M 32S	63D 14M 5S
02PE01CC0038 HILLSBOROUGH RIVER ESTUARY 72 M NE OF OIL TANKS AT END OF EFFLUENT PIPE, QUEENS COUNTY	46D 14M 35S	63D 6M 14S
02PE01CC0045 WHEATLEY RIVER ESTUARY FROM HWY 224 BRIDGE, WHEATLEY RIVER, QUEENS COUNTY QUEENS COUNTY	46D 22M 25S	63D 17M 19S
02PE01CC0047 ELIOT RIVER ESTUARY AT HWY 1 BRIDGE, BONSHAW, QUEENS COUNTY,	46D 11M 47S	63D 21M 4S
02PE01CC0049 COVEHEAD BAY 250 M WEST OF TIDAL OUTLET AT HWY 6, QUEENS COUNTY	46D 25M 40S	63D 9M 42S
02PE01CC0050 ELLEN'S CREEK AT HWY 1 BRIDGE, WEST ROYALTY, QUEENS COUNTY	46D 15M 50S	63D 9M 42S
02PE01CC0051 HILLSBOROUGH RIVER AT HWY 22 BRIDGE, MOUNT STEWART, QUEENS COUNTY	46D 21M 53S	62D 51M 57S
02PE01CC0052 WINTER RIVER AT HWY 6 BRIDGE, CORRAN BAN, QUEENS COUNTY	46D 22M 53S	63D 2M 19S
02PE01CC0054 WHEATLEY RIVER AT HWY 6 BRIDGE, CYMBRIA, QUEENS COUNTY	46D 24M 10S	63D 15M 12S
02PE01CD0001 COLVILLE BAY ABOUT 75 M SW OF KNIGHT POINT, SOURIS, KINGS COUNTY	46D 20M 46S	62D 14M 55S
02PE01CD0002 COLVILLE BAY ABOUT 110 M SE OF THE BREAKWATER BEACON, SOURIS, KINGS COUNTY	46D 20M 51S	62D 15M 16S
02PE01CD0003 COLVILLE BAY ABOUT 7 KM NE OF LOBSTER POINT, SOURIS, KINGS COUNTY	46D 21M 8S	62D 16M 0S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
02PE01CD0004 COLVILLE BAY ABOUT 450 M NW OF LOBSTER POINT, SOURIS, KINGS COUNTY	46D 21M 6S	62D 16M 40S
02PE01CD0005 COLVILLE BAY ABOUT 2 KM SE OF SOURIS HEAD, SOURIS, KINGS COUNTY	46D 19M 47S	62D 15M 28S
02PE01CD0006 COLVILLE BAY ABOUT 30 M WEST OF THE BREAKWATER BEACON, SOURIS, KINGS COUNTY	46D 20M 50S	62D 15M 26S
02PE01CD0011 BOUGHTON RIVER ESTUARY AT HWY 5 BRIDGE BRIDGETOWN, KINGS COUNTY,	46D 18M 31S	62D 31M 19S
02PE01CD0012 MIDGELL RIVER EAST OF MIDGELL AT HWY 2 BRIDGE, KINGS COUNTY	46D 24M 50S	62D 37M 34S
02PE01CD0013 FORTUNE RIVER SOUTH OF FORTUNE BRIDGE AT HWY BRIDGE, KINGS COUNTY	46D 20M 33S	62D 22M 45S
02PE01CE0001 CARDIGAN BAY ESTUARY OF BRUDENELL RIVER, 1.6 KM WEST OF GORDON POINT, KINGS COUNTY	46D 12M 10S	62D 36M 36S
02PE01CE0002 CARDIGAN BAY ESTUARY OF MONTAGUE RIVER ABOUT 0.8 KM EAST OF MONTAGUE, KINGS COUNTY	46D 10M 0S	62D 38M 6S
02PE01CE0003 CARDIGAN BAY ESTUARY OF CARDIGAN RIVER 0.8 KM WEST OF CRAWFORD POINT, KINGS COUNTY	46D 13M 28S	62D 35M 19S
02PE01CE0004 CARDIGAN BAY, CARDIGAN RIVER MOUTH 1.1 KM SE OF MAITLAND POINT, KINGS COUNTY	46D 12M 3S	62D 30M 6S
02PE01CE0005 CARDIGAN BAY, GEORGETOWN HARBOUR 530 M NE OF AITKEN POINT, KINGS COUNTY	46D 10M 24S	62D 32M 38S
02PE01CE0006 CARDIGAN BAY 30 M SOUTH OF CARDIGAN POINT, KINGS COUNTY	46D 10M 25S	62D 29M 48S
02PE01CE0007 GEORGETOWN HARBOUR ABOUT 495 M NORTH OF ST. ANDREWS POINT, KINGS COUNTY	46D 10M 8S	62D 31M 47S
02PE01CE0009 MURRAY RIVER ESTUARY IN CENTRE OF CHANNEL 400 M BELOW HWY 4 BRIDGE, MURRAY RIVER, KINGS COUNTY	46D 1M 1S	62D 36M 31S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
02PE01CE0010 MURRAY RIVER ESTUARY ABOUT 2.6 KM BELOW HWY 4 BRIDGE, MURRAY RIVER, KINGS COUNTY	46D 1M 18S	62D 34M 59S
02PE01CE0011 MURRAY RIVER ESTUARY ABOUT 1.1 KM EAST OF PLEASANT POINT, KINGS COUNTY	46D 1M 57S	62D 30M 9S
02PE01CE0012 MURRAY HARBOUR ABOUT 350 M SSW OF MCINNIS POINT, KINGS COUNTY	46D 2M 35S	62D 31M 47S
02PE01CE0013 MURRAY HARBOUR ABOUT 700 M NORTH OF CHERRY ISLAND, KINGS COUNTY	46D 2M 28S	62D 30M 16S
02PE01CE0014 SOUTH RIVER ESTUARY IN CENTRE OF CHANNEL 400 M ABOVE HWY 18 BRIDGE, MURRAY HARBOUR, KINGS COUNTY	46D 0M 9S	62D 31M 44S
02PE01CE0015 MURRAY HARBOUR ESTUARY ABOUT 220 M BELOW HWY 18 BRIDGE, MURRAY HARBOUR, KINGS COUNTY	46D 0M 22S	62D 31M 22S
02PE01CE0016 SOUTH RIVER ESTUARY IN CENTRE OF CHANNEL 1.3 KM BELOW HWY 18 BRIDGE, MURRAY HARBOUR, KINGS COUNTY	46D 0M 45S	62D 30M 47S
02PE01CE0017 MURRAY HARBOUR ABOUT 400 M EAST OF MACHON POINT, KINGS COUNTY	46D 1M 5S	62D 30M 8S
02PE01CE0018 MURRAY HARBOUR CHANNEL ABOUT 165 M SOUTH OF SABLE POINT, KINGS COUNTY	46D 1M 9S	62D 27M 17S
02PE01CE0019 MURRAY HARBOUR ABOUT 315 M NE OF SHARAMS POINT, KINGS COUNTY	46D 1M 27S	62D 31M 14S
02PE01CE0040 VALLEYFIELD RIVER ESTUARY FROM HWY 326 BRIDGE, MONTAGUE, KINGS COUNTY	46D 9M 18S	62D 39M 14S
02PE01CE0045 SEAL RIVER ESTUARY WEST OF VERNON BRIDGE, AT HWY 1 BRIDGE, KINGS COUNTY	46D 10M 40S	62D 54M 6S
02PE01CE0046 MURRAY RIVER ESTUARY FROM HWY 4 BRIDGE MURRAY RIVER, KINGS COUNTY	46D 0M 48S	62D 36M 42S

PRINCE EDWARD ISLAND

WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
03PE01CA0001 GULF OF ST. LAWRENCE ABOUT 300 M SE OF KILDARE POINT OFF ALBERTON HARBOUR, PRINCE COUNTY	46D 48M 9S	64D 1M 48S
03PE01CC0001 GULF OF ST. LAWRENCE ABOUT 1440 M NE OF LIGHTHOUSE AT NORTH RUSTICO HARBOUR QUEENS COUNTY	46D 27M 45S	63D 16M 46S
03PE01CE0001 NORTHUMBERLAND STRAIT ABOUT 2 KM NORTH OF MURRAY HEAD, KINGS COUNTY	46D 2M 9S	62D 27M 17S
10PE01CA0003 UNIONVALE SHALLOW WELL, 10 M DEEP, PRINCE COUNTY	46D 42M 50S	64D 12M 15S
* 10PE01CA0004 MOUNT PLEASANT WELL, PRINCE COUNTY	46D 35M 35S	64D 0M 5S
* 10PE01CA0005 BLOOMFIELD STATION WELL, PRINCE COUNTY	46D 46M 18S	64D 13M 14S
10PE01CB0010 SPRINGFIELD DRILLED WELL, (ROBERT JORGARSON), 39 M DEEP, QUEENS COUNTY	46D 23M 55S	63D 32M 50S
10PE01CB0011 ALBANY WELL, (ROBINSON & SONS), 9 M DEEP, PRINCE COUNTY	46D 16M 50S	63D 38M 35S
10PE01CB0012 NEW ANNAN DRILLED WELL, (W. MOOSE & SONS), 33 M DEEP, PRINCE COUNTY	46D 25M 25S	63D 40M 55S
10PE01CB0013 FERNWOOD DRILLED WELL, (CLIFFORD SHERRY), 25 M DEEP, PRINCE COUNTY	46D 19M 20S	63D 48M 45S
10PE01CB0014 MOUNT CARMEL DRILLED WELL, (J. ARSENAULT), 30 M DEEP, PRINCE COUNTY	46D 23M 35S	64D 1M 55S
10PE01CB0015 KELVIN GROVE WELL, (GEORGE MACMURD), 14 M DEEP, PRINCE COUNTY	46D 24M 35S	63D 39M 50S
* 10PE01CB0016 KENSINGTON WELL, PRINCE COUNTY	46D 25M 29S	63D 37M 52S
10PE01CB0017 SUMMERSIDE TOWN WELL 7, PRINCE COUNTY	46D 24M 57S	63D 46M 41S

*Water Survey of Canada, Water Level Monitoring Wells

PRINCE EDWARD ISLAND

WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
10PE01CC0012 PLEASANT GROVE DRILLED WELL, (NORBERT MORRISON), 20 M DEEP, QUEENS COUNTY	46D 22M 5S	63D 3M 20S
10PE01CC0013 COVEHEAD WELL, (ALVIN MACDONALD), 16 M DEEP, QUEENS COUNTY	46D 22M 57S	63D 7M 45S
10PE01CC0014 WINSLOE DRILLED WELL, (GERALD DALLAR), 30 M DEEP, QUEENS COUNTY	46D 18M 20S	63D 10M 45S
10PE01CC0015 KINLOCK DRILLED WELL, (KINLOCK POULTRY FARM), QUEENS COUNTY	46D 11M 52S	63D 5M 50S
10PE01CC0016 FAIRVIEW DRILLED WELL, (DELMAR CURVIE), QUEENS COUNTY	46D 10M 15S	63D 14M 55S
10PE01CC0017 LONG CREEK DRILLED WELL, (ARIE DE HONN), QUEENS COUNTY	46D 9M 55S	63D 16M 40S
10PE01CC0018 MEADOW BANK DRILLED WELL, (MIKE WITTING), 36 M DEEP, QUEENS COUNTY	46D 12M 45S	63D 15M 10S
10PE01CC0019 ELMWOOD DRILLED WELL, (STANLEY COLVELLE), 18 M DEEP, QUEENS COUNTY	46D 14M 55S	63D 20M 5S
10PE01CC0020 RENNIES ROAD DRILLED WELL, (ELMER MACDONALD), 63 M DEEP, QUEENS COUNTY	46D 22M 5S	63D 20M 55S
*10PE01CC0021 AUBURN WELL, QUEENS COUNTY	46D 17M 38S	62D 54M 9S
*10PE01CC0022 CUMBERLAND WELL 8, QUEENS COUNTY	46D 10M 8S	63D 10M 48S
*10PE01CC0023 NEW DOMINION WELL 23A, PRINCE COUNTY	46D 10M 14S	63D 15M 0S
*10PE01CC0024 HUNTER RIVER WELL, QUEENS COUNTY	46D 20M 15S	63D 21M 54S
10PE01CC0025 CHARLOTTETOWN WATER FROM MAIN MALEPEQUE PUMP, QUEENS COUNTY	46D 16M 11S	63D 9M 7S
*10PE01CD0001 ST. CHARLES STATION WELL, KINGS COUNTY	46D 23M 39S	62D 24M 1S

PRINCE EDWARD ISLAND
WATER QUALITY STATIONS : NUMERICAL INDEX

Station Number Location Description Station Parameters	Latitude	Longitude
10PE01CE0001 LOWER MONTAGUE DRILLED WELL, (DONAL ROSS), 32 M DEEP, KINGS COUNTY	46D 10M 20S	62D 34M 30S
10PE01CE0002 CARDIGAN DRILLED WELL, (HARRY NABURNS) 45 M DEEP, KINGS COUTY	46D 13M 40S	62D 37M 10S
10PE01CE0003 NEW PERTH SHALLOW WELL, (DEWAY FARM), 8.4 M DEEP, KINGS COUNTY	46D 12M 40S	62D 40M 40S
10PE01CE0004 GREENFIELD DRILLED WELL, (E. POWERS & SONS), 41 M DEEP, KINGS COUNTY	46D 9M 50S	62D 41M 35S
* 10PE01CE0005 CALEDONIA WELL, QUEENS COUNTY	46D 3M 48S	62D 42M 37S
10PE01CE0006 GEORGETOWN WELL, KINGS COUNTY	46D 11M 16S	62D 31M 45S

Appendix IV

Maps

Figure 1. PRINCE EDWARD ISLAND,
HISTORICAL WATER QUALITY STATIONS,
1961-1973

This foldout map indicates the water quality sampling locations for the stations used in this report. Although the NAQUADAT system employs a data processing (station) number comprised of 12 alphanumeric characters (e.g. 00PE01CA0001), only the significant digits of the stations' sequential number (last four digits) have been reproduced on the map. The complete NAQUADAT (data processing) station number can be generated in the following manner:

1. Observe the colour coding of the station dot and numeric in relation to water-type (below and map legend).

Colour	Water type	Code
Green	Stream and rivers	00
Brown	Lakes	01
Orange	Estuaries	02
Red	Open ocean	03
Purple	Groundwater	10

The above codes are the first two characters of the NAQUADAT station number.

2. Since all the stations are in Prince Edward Island, the province code is always "PE" (characters 3 and 4).

3. Note the watershed designation (sub- and sub-subdivision as defined by Water Survey of Canada*) which is denoted in bold black type on the map. Characters 5 to 8 inclusive define the watershed (e.g. 1CA = 01CA).

4. The final four characters (9 to 12) are the sequential numbers for the station. The significant digits of the sequential number appear on the map (e.g. 1 = 0001).

Example: The orange symbol west of CHARLOTTETOWN and designated 7 is NAQUADAT station 02PE01CC0007 since,

Orange	All Stations	"1CC" (in blk)	"7" (at site)
02	PE	01CC	0007

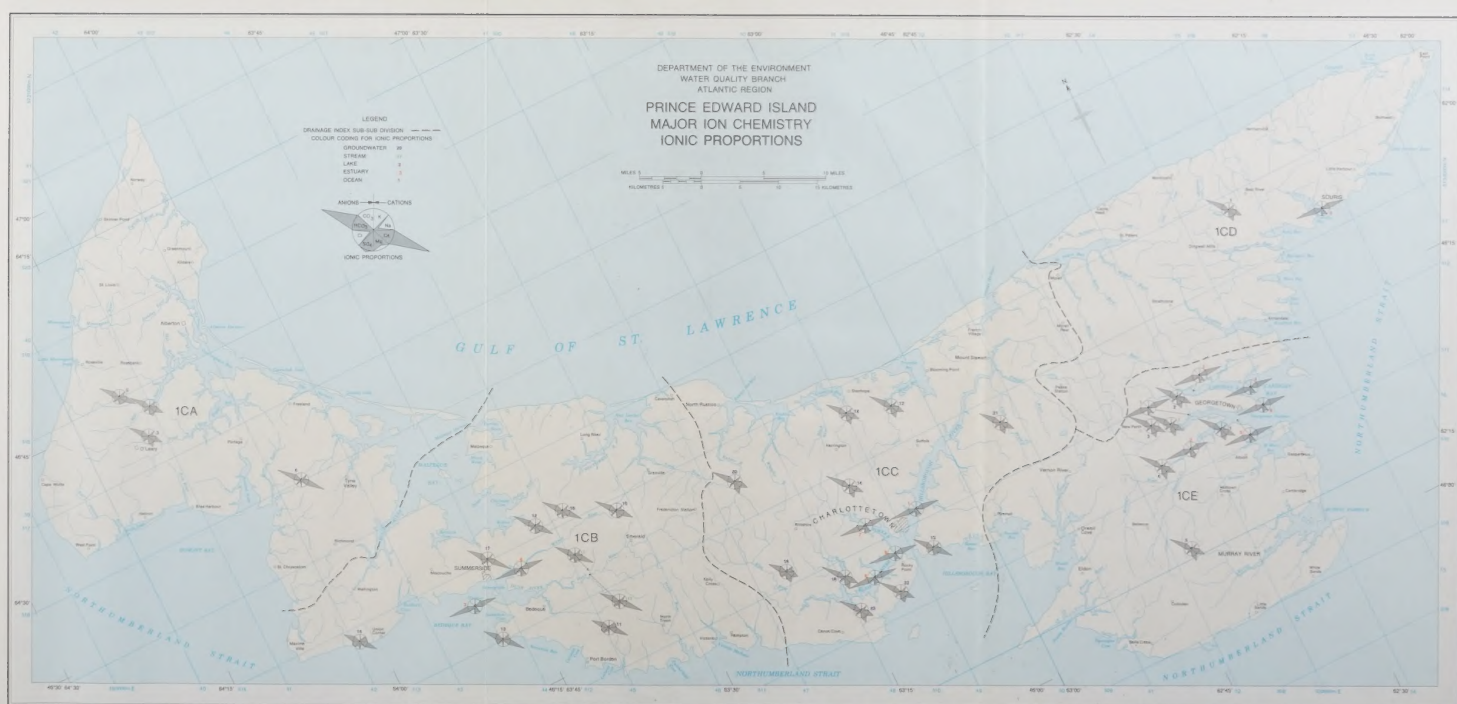
* Hydrometric Map Supplement, Reference Index, Canada, 1972, published by Water Survey of Canada, Inland Waters Directorate, Department of the Environment.



Figure 2. PRINCE EDWARD ISLAND,
MAJOR ION CHEMISTRY,
IONIC PROPORTIONS

Ionic proportion diagrams graphically illustrate the major ion chemistry of water. Only stations with at least 10 analyses of major ion chemistry have been presented on the map. The relative proportion (equivalent per cent) of each of the major ions are plotted on a "rose-type" diagram which is divided into two fields — "Anions and Cations" — by a vertical diameter. Thus each half (or field) represents 100 per cent of either anions or cations. Both fields are divided into four sectors to represent the four major anions and the four major cations (cf. Legend).

The concentration in milliequivalents per litre of the individual ions are calculated as percentages of either the anionic or cationic field. The length of the bisecting radius in each of the sectors is proportional to the equivalent concentration of that ion and thus the enclosed polygon (shaded area) is directly proportional to the equivalent per cent of that ion. Since there are four ions in each field, the circumference of the circle represents 25 equivalent per cent. Thus, values of less than 25 per cent lie within the circle, whereas values greater than 25 per cent extend beyond the circle.



CA1 EP 76078W01

Canada, IWD.

Water Quality Interpretive Report No.1

WATER QUALITY INTERPRETIVE REPORT, PRINCE EDWA

1961-1973. 1978.

UNIVERSITY OF TORONTO
INSTITUTE FOR ENVIRONMENTAL STUDIES

